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DEATH OF CHARLES E. SANDERSON.

Mr. Charles E. Sanderson, connected with the JOURNAL since January, 1870, and for many years its business manager, died at his home in Brooklyn, N. Y., the afternoon of the 20th inst. He was in his 61st year, having been born in Williamstown, Mass., April 27, 1846.

[Special Editorial Correspondence.]

THE THIRTY-SEVENTH ANNUAL MEETING OF THE NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

YOUNG'S HOTEL, BOSTON, MASS., FEB. 20, 1907.

Dear JOURNAL: Last evening old Young's presented an animated appearance, not that it is ever in any sense superannuated, so the mention of old at all is simply made to show that it is dear to the memories of New England's gas men, whose annual trystings there are now well on to two-score. The weather was of the mid-February Boston type—raw, rainy and rasping—wherefore, it was quite reassuring from the point of view that so many *avaunt courriers* betokened a good and representative attendance. A feature of the doings in the evening was the annual reunion banquet of the Presidents, which was heartily enjoyed, and another feature of the night was the varied entertainment that went on in "Parlor F.," which reflected all the more creditably on its originators, the affair having been quite impromptu. The raucous night atmospheric conditions were followed by far better ones to-day. Indeed one could scarce cavil thereat, for it was dull but dry. When Captain McGregor, of Pawtucket, R. I., sounded the gavel from the President's desk, every chair in the assembly room was occupied, and every occupant was ready for the work before him. Secretary Gifford, looking as sedate and unruffled as is his wont, having put the house in order, the earlier routine matters were easily and readily disposed of. These included the reports of the Directors on the election of new members, of the Secretary and Treasurer, the reading of correspondence and some general announcements. New members to the number of 12 were elected, and the list of correspondents was lengthy. The first real sound of the session came in the address of President McGregor. In it that alert minded gentleman put in his paragraphs much that was sentient, much that was forceful, much that showed how quick he is to notice, gather and analyze. From his sense of personality, well blended with the heart coloring that impels regard and sustains close friendship, I cannot forbear from quoting from his message the closing passage that refers to the Association's dead in the year—and in this blighting regard the Association suffered much. Having named the lost ones the Captain said: "Some of them, as you know, had arrived at the allotted span of man, had endured the heat and burden of the day, had lived lives of rich and honorable achievement, and their listing had been fulfilled; but others in the full flush of early manhood, brilliant and accomplished, eminent and strong, have had to lay down work upon which they were just starting, and leave in evidence but the earnest of what they would have accomplished. All of them had those lovable qualities so admirable in man: A high standing in their profession; characters flawless and enviable; a loyalty and devotion to duty that is deserving of our emulation. We respected and honored them living; their memory is of precious savor; they rest from their labors, and our hearts follow them."

What sweeter laudation could be chaunted, what grander tribute could be given than these! A few more preliminary details paved the way to the paper list, which was begun with the number on "The Present and Growing Need for the General Adoption of a Uniform System of Records and Accounts," by Mr. A. C. Humphreys, President of the Stevens' Institute of Technology, of Hoboken, N. J. Time is putting its imprint on him rather gently in the flesh, for he is still lithe and bright of mein, but the student's tuft seems altogether too prominent now. However, "from each head some hair must fall." The paper was a thoroughly clever one, and that it was greatly appreciated by its hearers was well shown in its reception and the discussion that followed. The discussion brought the morning session of the first day to a close. —C.

LIBRARY OF CONGRESS. FEB 25 1907 SMITHSONIAN DEPOSIT.

The afternoon session was commenced at the hour named in the recess resolution, the attendance being quite up to the straining point of the Convention room. Without delay President McGregor had the proceedings in smooth way and under perfect control. The first regular topic to engage the members was the excellent paper by Mr. E. N. Wrightington, Secretary of the Boston Consolidated Gas Company, on "Some Commercial Departments in the West." His pithy paragraphs evoked a spirited and valuable discussion, and the hope was expressed that the author, now that he had made such a forceful entrance into the paper preparers' ranks would soon be heralded again therein. The debate on the paper was interrupted, and happily, by the entrance of Curtis Guild, Jr., Governor of Massachusetts, whose pleasant welcoming of the members, added to his pointed remarkings on the relations of the State, the municipality, and the consumer to the suppliers of lighting on all accounts, were received with a salvo of applause. The discussion having been resumed and completed, the Question Box was appealed to and not in vain, several queries taken therefrom bringing out much of interest. The next paper was that by Secretary Gifford, who submitted a series of statements, and figures reciting "Some Instances of School Room Lighting." The discussion on it was rather brief, in that the paper showed the subject concerned matter of a public nature not yet finally determined by the school authorities of Boston. Now came the appointment of a special committee charged with the investigation of a certain line of thought traceable to the paper by Dr.

Humphreys. The report of the Committee on Nomination of Officers having been submitted and agreed to the following bearers were elected in the usual way:

President.—Capt. Wm. McGregor, Pawtucket, R. I.
First Vice-President.—J. E. Nute, Fall River, Mass.
Second Vice-President.—W. G. Africa, Manchester, N. H.
Secretary and Treasurer.—N. W. Gifford, Boston, Mass.

The response to his retention in office by Capt. McGregor was as clean cut and clever as could be. To a certainty he is a capable leader. Brother Gifford accepted the inevitable with his usual composure, nor did the suggestion that he be a trifle more alert in respect of seeing to it that the papers were printed in time for the sessions—the humor of this is in the fact that the Secretary's own paper had not reached the printer in time. A recurrence to the Question Box concluded the actual business for the day and the banquet hall is being arranged for the spreading of the provender and the flow—of reason.—C.

Almost on the forwarding of the above lines, and shortly after adjournment of the day's sessions, came the sad news, by long distance telephone, of the death of Mr. Charles E. Sanderson, for 37 years in the service of the JOURNAL the first day of the current year. His long and patient struggle with disease, lasting since the fall of 1900, is well known to the fraternity, but at the last the sad ending of the combat comes with a jarring shock. At those meetings he had been a participant since 1874, and it is certainly within the knowledge of the writer that the New England Association of Gas Engineers did not have within its active ranks a man who did heartier work for the advancement of its aims and ends. I shall not recite about the sweet words of regret over him that have been said to me, save that the tenor thereof sounded of affection, tuned to diapason of sorrow.—C.

YOUNG'S HOTEL, Feb. 21, 1907.

Dear JOURNAL: The banquet last evening was in the usual style of such functions given under the direction of the New England Association, although towards its close a strikingly beautiful, even though sorrowfully solemn tribute, was paid by the assemblage to the memory of Mr. Sanderson. The tribute was heartfully and impressively rendered by Mr. Walter R. Addicks who, although no name was mentioned, made it plain to everyone that the tribute was to him who had so often been with them, both in the session's room and at the banquet table. Perhaps it would be well not to refer at length to what was done in this sad but loving respect at Young's last night; it likely is sufficient to say that it was well done. The toastmaster was Captain William McGregor, and he acquitted himself as the director of the feasting as capably as he did in directing the business sessions. Mayor Fitzgerald was the guest of honor, and his speech was one that, even if it did savor a trifle of repetition, was of the type for which he is well noted. Brother Prichard, by-the-way, may be here written as a great authority on odd illusions and strange delusions. Well over 100 shared in the pleasures of the party.

The technical business of the second day was really opened by the paper on "The Process of Making Incandescent Gas Mantles," by Mr. M. C. Whittaker, of Gloucester, N. J., Superintendent of the Welsbach Company shops. The author's lucid description of the gas mantle making industry was most complete, and his replies to some pointed questions put to him in the debate were quite up to the high standard of the paper itself. The next number concerned "Method of Removing Naphthaline from a Sixteen-Inch Pipe," and the author was repaid for his clear description of how he accomplished a besetting task by a brisk discussion on the subject. Mr. S. J. Fowler, of the Charlestown (Mass.) Company, having presented his explained "Diagram of Changes in Output, 1890 to 1905," which presentation also aroused a brisk debate. Secretary Gifford's paper on "Some Instances of School Room Lighting," which certainly bristled with suggestive points for discussion, was not really threshed out at all, for reasons perfectly satisfactory to the author and to the Association. A number not on the regular list came to hand in a charting by Mr. E. H. Yorke, of Portland, Me., of "Rules and Regulations for the Extinguishment of Fires in Gas Works." The chart and schedules showed how thoroughly Mr. Yorke had gone into the subject. Owing to illness Mr. Yorke was unfortunately prevented from attending the meeting.

Another welcome surprise was the presentation, by Mr. J. B. Klumpp, of copious renderings from jottings in his notebook respecting a recent somewhat lengthy sojourn in England and Scotland, the trip having been made for the purpose of studying closely the to-day conditions prevailing there in the manufacture and distribution of gas. Although the brisk recital occupied full ¾ of an hour, Mr. Klumpp at the close of it got a rousing recognition for the merits thereof. Of course, the policy of taking up a question or two for discussion between papers was adhered to, and the propounder of the query respecting the sulphur content and yield of gas per pound of the standard coals of to-day as compared with those carbonized some years ago, should be well satisfied over the "experiences" that were freely given. Over a score of debaters took part in the debate. The business proper was brought to a close shortly before 1 P.M., and when the gavel fell those who shared in the meeting felt that they had been well repaid for the time and other expenditure given to attending the "New England's Thirty-seventh." For the afternoon, visits to various points of interest to gas men in and around Boston had been arranged, but by far the larger number of delegates evidently had determined to accept the invitation of the managers of the Boston system of elevated railroads to inspect the large gas producer station for the actuating of gas engines used in connection with the Company's system of propulsion. The weather was all that could be desired for such a trip. Only one verdict goes in connection with the meeting—it was a complete success.—C.

BRIEFLY TOLD.

FEBRUARY MEETING, PHILADELPHIA SECTION, ILLUMINATING ENGINEERING SOCIETY.—The February meeting of the Philadelphia Section of the Illuminating Engineering Society was held in the display room of the Welsbach Company, 922 Chestnut street, Friday evening, February 15th. Mr. Thomas J. Litle, Jr., Engineer of the Welsbach Company, gave a talk, illustrated by lantern lights and several hundred historical models, upon the development of the art of Incandescent Gas Lighting. He dwelt especially upon recent improvement in inverted lighting. The discussion that followed his talk was very keen, the electrical men asking many questions bearing upon the efficiency and use of inverted lights. Officers for 1907 were elected as follows:

Chairman—I. H. Francis, Jr.
Managers.—R. J. Rolston and B. L. Cates.
Secretary.—Walton Forstall.

[Concluded from Page 274.]

Report of Committee on Electrolysis, Prepared for the American Gas Light Association, and Submitted to the American Gas Institute on Behalf of the Former as a Contribution to the Proceedings of the Latter.[1]

(B) DANGER AND CORROSION.

These results can be regarded from two points of view:

1. The special results of the Elberfeld measurements.
2. The generally applicable results which can be deduced from 1.

1. The special results of the Elberfeld measurements can be summarized as follows:

(a) Electrical conditions.

The maximum difference of potential between two points of the rail network was from 3.5 to 4 volts. (The Croneberger road is not included in this because measurements could not be made there owing to the absence of test wires.)

Currents up to 3 amperes were found by measurements on the pipes. It has been proven that, under certain circumstances, current escapes from the pipes to the earth, or to other pipes through which the current continues, even in districts where the pipes are negative to the rails. Wherever pipes cross there is more or less escape of current from one to the other, as small potential differences usually exist between different pipes. The passage of currents from the pipes is spread over a comparatively large district and seems to be strongest near the connection point of the return conductor closest to the electric power station. The return cables do not produce equal potentials at the connection points in the rails, as these cables are not proportioned to the strength of current which they carry during the present service. By the insertion of adjustable resistances in certain of the return lines improvement could soon be secured. By increasing the number of return cables the differences of potential in the rail network can be further reduced and limited to any desired degree.

(b) Damages.

A gas pipe, which was situated near the rails not far from the first return connection, was badly oxidized on its entire circumference in consequence of the escaping earth currents. The oxides acted on the surrounding soil for a distance of more than ¼ of an inch. The surface of the iron itself was changed, to some extent, into a soft, graphite-like mass.

2. *The Generally Applicable Results.*—Such pipes are most endangered which form a connection between rail districts possessing a high potential and those possessing a low potential, or which connect points having a good conducting medium through the earth with other points of very different potentials. The danger district is generally near the connection points of the return lines or near similar points of low potential. The location of the endangered are as also depends considerably upon the resistance between the pipes and rails as well as on the chemical composition of the soil.

(C) PROTECTIVE MEASURES.

The "Regulations" issued by the Commission are given on pp. 137–143.

Frankfort-on-Main. W. H. LINDLEY, Chairman.

The "List of Questions" referred to in the foregoing report, issued by the German Electrolysis Commission, 1904:

1. When was the electric tramway service started in your city?

2. What is the nature of the return circuit? (a) Are the rails used without auxiliary cables? or (b) Are auxiliary cables used and are these insulated or uninsulated? What is the cross section of these return feeders relative to the outgoing feeders?

1. This report is limited to the consideration of direct current electricity, and is, therefore, contingent upon future developments in the use of alternating current electricity for traction purposes.

3. Were return feeders installed when the road was first put in operation, or were they added at a later time; and if so, about when were they added and for what reason?

4. Have any arrangements been introduced in the power house or in the rail network for the purpose of diminishing the potential differences between different parts of the grounded rail network? If so, what are these arrangements and when were they installed?

5. Have you noticed any electrolitic destruction of water or gas pipes, and if so, of which pipes?

6. If so, what evidence is there to indicate that the destruction was due to the return current from the tramway, or can the destruction be otherwise accounted for?

7. Have you noticed that the destruction is more especially confined to certain parts of the pipe network? If so, which sections or points have been most seriously affected?[1]

8. Has the destruction been particularly severe in any one section of the city; and if so, how do you account for this? Can the conclusion be drawn that in this section a peculiar condition of the soil exists; and if so, what is this condition?

9. Have you noticed whether the destructive influence is greater with conductors of a certain material; and if so, with what material?

10. If your answer to (5) is "No," have you for any other reason investigated the question of electrolytic destruction, and have you made any observations or measurements in this connection?

11. What results and conclusions have you obtained from your observations and measurements?

12. Does the soil in your city contain characteristic chemical constituents such as chlorides, sulphates, etc., which might attack the pipes or favor electrolysis from railway return currents?

13. If you cannot prove that the damage to your pipes was due to electrolysis, has the damage to the pipes increased largely since the electric tramway has been in operation?

14. Can you give the approximate number of annual repairs which were made to your piping system for a period of say 3 or 5 years before and after the electric tramway service was started?

The "regulations" referred to in the foregoing report, issued by the German Electrolysis Commission, 1904:

1. *Current Supply.*—The trolley wire is to be connected to the positive pole and the rails are to be connected to the negative pole of the generator by means of insulated cables.

2. *Rail Network.*—All rails which are used for the return current are to be made as good and reliable conductors as possible. To this end:

(*a*) If the rail joints are not welded, they must be permanently bonded by means of copper wire not less than 8 millimeters in diameter. This rule applies also to cast joints. The resistance of the finished track is never to be more than 20 per cent. higher than that of an unjointed track of equal length and section.

(*b*) The rails of a track must be connected, at least every 50 meters, with a cross bond similar to that at the rail joints; adjacent tracks must in addition be cross-connected, every 100 meters or less, with a bond wire of at least twice the cross section of the other bonds.

(*c*) The track must be provided at all crossings and switches with connecting bonds, constructed in accordance with rule 2a, which completely bridge the switch or crossing with a good conducting connection.

(*d*) At all movable bridges and at all other points where the tracks are interrupted, the separate portions of the track must be connected by insulated cables of suitable size to insure the permanent electrical continuity of the track system.

3. *Potential Difference in the Rail Network.*—The potential difference in the rail network must be limited to a certain prescribed amount, which must not be exceeded with the greatest or most unfavorable loading of the return circuit. The greatest permissible potential difference must be determined for each place separately, for it depends upon local conditions, such as the nature of the soil, the location and resistance of the pipes between points of highest and lowest potentials, the position of the pipes with respect to the rails, etc. In special cases, this greatest permissible potential difference may be different in different sections of a rail system.

For the present this maximum permissible potential difference in the rail network may be taken as 1 *volt;* this figure to be the average of readings taken for 10 minutes during a period of full load.

4. *Return Conductors.*—Where the rails alone are not sufficient for the return current, without allowing the potential difference to exceed the prescribed amount, extra return conductors must be provided. These return connections must be so numerous and so planned that, in conjunction with good conductivity of the rail network, they prevent the potential difference in the rails from exceeding the prescribed amount. The points where the return conductors are connected to the rails should be located as far from the pipes as possible. The return conductors must be insulated and of sufficient size to return the current with only a small drop in voltage; so that, if an occasional change in the distribution of the current occurs, no excessive difference in the potentials at the connection points of the return conductors will be produced.

The return conductors should have a cross section at least equal to that of the outgoing conductors; where conditions require a number of return conductors, it may be better to make them of larger cross section than the outgoing conductors.

5. *Return Connections for Auxiliary Installations.*—Stationary motors and electric lamps, which are supplied from electric railways employing the rails for the return current, must be connected to the return conductors or to the rails by means of insulated cables; but the potential difference in the rails must not be increased thereby above the permissible limit given in rule 3. It is not permissible to connect one pole of such a motor to the ground by earth plates or otherwise. The frame of the motor must be grounded, but must not be connected to one pole of the motor.

6. *Adjustability of the Return Conductors.*—An essential condition for minimizing the potential difference in the rails, and, therefore, the stray currents, is that the potentials be equalized at all points where return conductors are connected to the rails. The resistance of each return conductor must, therefore, be proportional to the strength of current which it has to carry. For this purpose each return conductor must be provided with an adjustable resistance (or negative booster), so that the product of current and resistance may be made the same for all return conductors.

7. *Negative Boosters* (*Sucker Dynamos*).—Negative boosters are to be recommended, particularly for the purpose of automatically regulating the rail potentials at the connection points of the return conductors in districts where the return conductors are liable to be frequently or seriously overloaded.

8. *Controlling Arrangements.*—Test wires must be led to the distributing station from all points where return conductors are connected to the rails, and from all points of relatively highest potentials in the rail network (points between two return connections and points at the end of the track). By connecting a voltmeter it must be always possible to determine the potentials of these points in the rails. Arrangements must also be provided so that the current in any one of the return conductors can be measured at any time. Whenever the opportunity occurs, test wires should be attached to characteristic points in the piping system. These test wires should terminate in small boxes attached to nearby walls, so as to be always available for measuring the potential differences between the pipes and the rails and the currents in the pipes; these wires should be carefully protected.

9. *Resistance between Rails and Earth.*—The resistance between the ground and rails carrying return current must be kept as high as possible. When this resistance is not sufficiently high, owing to conditions of the ground or of the roadbed, special steps must be taken to increase it by means of suitable installation. To accomplish this it is recommended that the rails be laid upon a dry bed of broken stone or gravel, or upon a layer of poor conducting material, or upon a concrete foundation at least 25 centimeters wide and 15 centimeters thick, having on top of it a layer of asphalt at least 1.5 centimeters in thickness and projecting not less than 5 centimeters at each side of the rail. The dryness of the earth about the rails is an important element in this resistance. For this reason it is of great importance to render the road surface between and near the rails impervious to water and to drain the subsoil. To make the roadbed watertight it is best to finish it with asphalt, or with stone or wood pavement set and grouted in asphalt, for a distance of at least 50 centimeters beyond the outermost rails.

Metallic connections between the rails and the earth, by means of earth plates and the like, or between the rails and subterranean metal not belonging to the tramway network, reduce the resistance between the rails and the earth and must not be permitted. Wherever existing, they must be removed. The use of salt to thaw snow and ice is injurious, and should either be utterly prohibited or permitted only in case of emergency.

10. *Connections between Rails and Pipes.*—Metallic connection of the pipes with the rails or with the return conductors or with the negative bus bar must under no circumstances be permitted, and must be removed wherever present. Such connections bring the pipes in parallel with the rails or return conductors and produce destructive

1. If possible, a plan of the city showing the piping system and the points of destruction should be added.

actions at the invariably numerous points of imperfect contact in the pipes, such as in joints, valves, etc.

11. *Distance between Rails and Pipe Fittings.*—The shortest permissible distance between rails and such fittings (hydrants, stopcocks, etc.) as are in metallic contact with the pipes and reach or approach the surface of the road, is *one* meter. Where this distance is less, the fittings should be transferred, or, if this be not possible, the electrical connection between them and the upper layer of earth must be interrupted by earthenware covers or brickwork, or in some similar manner.

12. *Protective Devices for Pipes.*—Pipes which cross under the rails should be insulated for a distance of at least 1 meter beyond the outer rails, or they should be provided with auxiliary covering pipes, in good metallic contact with the pipes proper, through which the electrical connection to the earth is made. Where 2 pipe systems cross or approximate each other, they should for mutual protection be metallically connected together wherever other conditions permit; that is, where the potential differences involved are slight, etc.

13. *Application of the Rules.*—These rules either do not apply, or apply only to a limited extent, to electric railways outside of the gas and water districts.

14. *Examination of Existing Installations.*—With regard to existing electric railways, tests should be made of the electrical conditions of the rails and return conductors under full load operation, in order to determine to what extent they fulfil these requirements. The following conditions, particularly, should be determined:

(*a*) The potential differences between the negative bus-bar and the various characteristic points in the rails, *i. e.*, points where return conductors are connected, points of relatively highest potentials, etc.

(*b*) The potential differences between the points mentioned in (a) and a suitable earth connection lying in ground water.

(*c*) The potential differences between the negative bus-bar and a number of characteristic and suitably distributed points in the pipe network.

(*d*) The potential differences between the rails and the gas and water pipes at the above mentioned points. It is advisable to make these measurements at the water pipes, and either directly on the pipes or on a hydrant; valve spindles do not offer sufficiently good contact for this purpose.

The results of these measurements are best plotted on a plan of the tramway system. The potentials of the rails, with reference to the negative bus-bar and to the pipes, should be indicated on this plan; and the zones should be determined in which the pipes are positive to the rails, and where currents are likely to pass from the pipes to the earth and to the rails. The potential differences between suitable points in the pipe network (hydrants, etc.), should be determined: First, when the tram service is suspended; and, secondly, when it is in full operation. From these results the direction of the currents in the pipes can be ascertained, and the districts can be approximated where current is leaving the pipes. In connection with these tests, the strength of the currents in the pipes can also be determined where necessary. In districts where the pipes and rails approximate or cross each other, and in the neighborhood of the return connections, excavations should be made and the condition of the pipes should be determined by inspection. Then, it must be estimated at what crossings or points of proximity currents are likely to pass from one pipe to others, either belonging to the same or to another piping system. At such points, also, the pipes should be uncovered and inspected, and the potential differences should be measured when the tram service is in full operation.

The above will serve as a basis for deciding what protective measures should be employed locally for the preservation of the pipes. By promptly installing the adjustable resistances in the return conductors specified in rule 6, and also the measuring arrangements specified in rule 8, it is probable that very considerable improvement in the electrical conditions in many installations can be soon obtained.

15. *Control During Operation.*—During the operation of the road, and particularly during times of greatest or most unfavorable load, the distribution of potentials in the rails must be regulated as required. The resistances of the return conductors are to be adjusted so that the potentials of all points where the return conductors are connected to the rails shall be as nearly equal as possible. The strength of current in each return conductor should also be adjusted at the same time. Such adjustments are especially to be made whenever there is a change in the traffic condition. Whenever the insulation of the lines is measured, or at least twice every year, the resistances of the rail joints should be measured, by means of a bond tester (differential voltmeter), to see if they meet the requirements of rule 2a.

The measurements made at the station before and after adjusting the resistances, and other tests, as well as the resistances of the rail joints, are to be recorded on a sheet which must be open at all times to the inspection of the gas and water officials.

Discussion of the foregoing Report and Regulations by the Chairman of the Commission[1] at the Annual Meeting of the Society in 1904:

Briefly, in regard to the list of questions, the following remarks may be made:

Of the 130 answers received referring to 113 cities, 109 possess electric railway systems. Of these 56 per cent. make use of the rails without return conductors, 37.5 per cent. make use of the rails and insulated return conductors, and 6.5 per cent. make use of the rails and uninsulated return conductors.

The question whether electrolytic destruction had been observed was denied in most cases, and only 14 cities, or 13 per cent. of the total, answered this question affirmatively. From these denials the conclusion cannot, however, be drawn that no destruction had occurred in these cities, for later, upon uncovering the pipes in some of the cities which had answered in the negative, considerable damage was found. In some cities having water and gas systems independent one of another, the one commissioner answered the question affirmatively, the other negatively.

A glance at the answers to the question regarding the condition of the return system shows that these are generally poor, and that the question of protecting our water and gas piping through suitable devices applied to the return system of electric railways has not received sufficient attention.

Under these conditions, the fact should be again emphasized that the many denials of damage cannot be considered final. We are dealing with return currents which must largely pass through the ground, and which will naturally pass through our pipes, these being good conductors. Under certain conditions of the soil and water, and with suitable positions of the pipes relative to the rails, these stray currents must produce destructive influences. It is, therefore, only the intensity of these currents which determines the time in which the destructive effects will become evident.

As the thickness of the water pipes is not based on the internal pressure used, but is made much heavier for practical purposes—especially in case of the smaller sizes which are made several times heavier—these pipes are able to stand this gradual deterioration for a number of years. However, even where the action is very slow, its effect will in time make itself evident.

The long list of tests at Elberfeld shows the resistance of different kinds of pipes, and has developed correct methods of measuring, the details of which would exceed the limits of this paper. The potentials at different points of the track relative to the minus pole of the dynamo were measured, and the potential differences in the track and in the return conductors were thus ascertained. The potential differences between the piping system and the negative pole of the dynamo, and between the pipes and the track, were also determined at different points, as well as the potentials of the track relative to a neutral ground point.

The differences of potential between the track and the piping system were then laid out on the city map. The curve through these points has a width equal to the maximum potential difference and crosses the track line where the potential difference is zero; positive readings, where the current flows from the rails to the pipes, were laid off on one side, and negative readings, where the current flows from the pipes to the rails, were laid off on the other side of the track lines. The latter places indicate where disturbances are to be looked for. From such curves the points of greatest potential difference and their location on the track system may be readily seen, and the danger sections may be readily marked on a map which shows the relative positions of the tracks and the pipes. The pipes in these places of probable greatest destruction should be examined.

It was, at first, the opinion of the Commission that it could determine only general points of view. After careful discussion, however, only one point appeared to be left which was really in doubt; namely, the greatest permissible potential difference between the track and the pipes—in other words, the highest potential difference in the track system at which it may be assumed that no destruction will occur.

The Commission is not yet able to present a definite proposal on this subject. In fact, no universal rule can ever be given, because the permissible potential difference depends largely upon local conditions. The potential difference in itself is not the determining factor, except in so far as it determines the strength of the current, which, in turn, de-

1. Condensed translation.

pends on the resistance of the earth and of the piping system; and this resistance is a variable quantity, depending upon the degree of dryness or dampness, the chemical and mechanical composition of the earth, and the distribution of the piping system. Several years of investigation under the various conditions will probably be required to reach satisfactory conclusions regarding this question, and even then it will not be possible to issue definite rules which can be universally applied, but only to give to the administrations concerned such information that they can determine for each place the permissible potential difference best suitable to the local conditions.

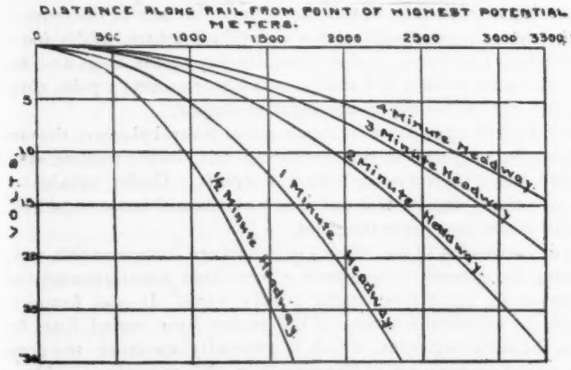
The Commission believed that its object would be best promoted by presenting its recommendations in a set of regulations designed to improve the existing conditions, leaving the question of the highest permissible potential difference at which there would be no destruction to be settled at a later time. This leaves a gap which at present we can bridge only temporarily, but which every one will be able to fill in for himself later on. These regulations will now be briefly discussed:

Paragraph *One* requires that the trolley wire should be connected with the positive pole, and the rails with the negative pole, of the dynamo.

Paragraph *Two* requires, above all, that the rail system be a good conducting medium, and that the rail joints be connected by copper bonds so that they should form a perfect electrical connection even if a loosening of the rail joints should occur. It also states that the resistance of the entire track must not exceed the theoretical resistance of the 2 uninterrupted rails by more than 20 per cent. The cross connections insure that, if one line of rails should be interrupted, the other could then do its work without an undue increase in potential.

Paragraph *Three* requires that the potential difference in the track shall not exceed a certain small amount. By this difference is meant the difference in potential between a return point and the point of highest potential between two return points, or between a return point and the furthermost end of the track system. As before mentioned, the Commission cannot propose a final and generally applicable value for this greatest permissible potential difference; but, as it appeared necessary for existing electric roads and those under construction to have some information regarding this point, the Commission proposes that the highest permissible potential difference in the track system be placed at 1 volt, this to be the average reading at full load for a period of about 10 minutes.

In order to illustrate the drop in a track system under different traffic densities, the accompanying diagram has been prepared.



Curves Showing Voltage Drop in a Double Track System Used for the Return Current with Different Traffic Densities.

Assumed Figures.

Resistance of 1 kilometer of single rail		.036 ohm.
" 1 "	double track	.009 "
Average current used by 1 car		16 amp.
" speed of car		16 km. pr. hr.
Distance between cars on the double tracks...	with ½ minute headway	.67 meter.
	" 1 " "	.133 "
	" 2 " "	.267 "

The curves are calculated for cars running under ½, 1, 2, 3 and 4 minutes headway on each track, and start at the point of highest potential between two return points. These curves show the relation of the distance between points of return connection and the highest permissible potential difference, with different traffic densities.

The potential difference of 1 volt is obtained under the following conditions:

With ½-minute headway at 1,900 meters between return points.
" 1- " " 2,700 " " "
" 2- " " 3,800 " " "

The diagram shows that the increase of the permissible potential difference to 2 volts causes only a small increase in the distance between the return points; *i. e.*,

With ½-minute headway only from 1,900 meters to 2,700 meters.
" 1- " " " 2,700 " 3,800 "
" 2- " " " 3,800 " 5,400 "

These distances between connection points for a drop of 1 volt should demonstrate that this demand for the track return equipment is not unreasonable.

Paragraph *Four* states that special return cables must be installed if the track system is not in itself sufficient to carry the return current with the drop limit of 1 volt; and that these, in contrast with many present installations, must be insulated.

Paragraph *Five* requires that the resistance of the return conductors be made controllable. It is remarkable that this is not the case in a great many electric railway installations. If the object which we have in view is to be attained—namely, to reduce to a minimum the potential differences in the track system, which are the cause of the stray currents—then, above all, we must be able to control the potentials at all of the points where the return conductors are connected to the rails so as to keep these return points at the same potential.

Paragraph *Six* proposes, in special cases, where the conditions of traffic make it desirable to overload a particular return conductor either temporarily or permanently, but where it is undesirable to raise the potential of the entire track system, to use a negative booster to lower the potential at the point where this particular return conductor is connected to the rails, and thus artificially induce the current to return by this conductor to the negative bus-bar.

Paragraph *Seven* requires special test wires to be led to the central station from all points where the return conductors are connected to the rails and from all presumptive points of highest potential in the rails, arranged so that the potentials at these points can be observed and regulated accordingly. In this way the changes of potential in the track system, due to changes in traffic on Sunday, holidays and special occasions, can be detected, and the resistance in the return cables regulated so that, even under these conditions, a nearly uniform potential at the return connections can be secured.

Paragraph *Eight* deals with the return conductors for auxiliary installations such as motors, lights, etc., and requires that in such installations the negative terminals be connected to the rails or to the return conductor, by means of insulated cables.

Paragraph *Nine* deals, first, with the resistance between the rails and the ground, which is one of the most important questions. If it were possible to insulate the track from the earth, an ideal condition for the protection of the piping system would be obtained. As this is not possible, the resistance between the rails and the earth should be kept as high as practicable by means of sand, gravel and broken stone placed around the tracks, and by making the surface waterproof, etc.

Other recommendations are given in this paragraph: Minimizing the use of salt for thawing purposes is advised, because the salt water penetrates into the ground and produces a higher conductivity. Wherever this brine reaches the pipes an increased danger is produced, so that the Commission proposes either to entirely prohibit the use of salt or to limit its use to emergency cases. Above all, the frequent mistake of intimately connecting the rails with the earth by means of earth-plates must be rectified. This arrangement is so manifestly wrong that it does not seen possible anyone should favor it. It must, therefore, be absolutely demanded that no such connections be made, and that those already existing be promptly removed.

Paragraph *Ten* deals with connections between pipes and rails. The pipes and the rails have been sometimes metallically connected at the points where the current leaves the pipes and passes back to the rails, because the most harmful effects exist at these points and it was thought that such connections might remove the danger. This would be reasonable, if it were not for the fact *inter alia* that a poor contact is obtained at all hub and spigot and other pipe connections, and at these points the current causes immediate electrolytic action. With such metallic connections, that particular section of the pipe is placed in parallel with the rails, the current carried by the pipes is proportionately increased, and, instead of having one place of current leakage, we obtain many points where the current passes into and out of the pipe. It is, therefore, requested that this class of metallic connection be avoided, and that the existing ones be removed.

Paragraphs *Eleven* and *Twelve* advise as great a distance as possible between the pipes and the rails, and, where necessary, the application of special protective devices to the pipes.

Paragraph *Thirteen* describes the railways to which these regulations are applicable.

Paragraph *Fourteen* deals with the Elberfeld measurements and tests. This paragraph also describes how to obtain a curve for any given city, which readily shows the potential difference between the piping and the tracks, and the *danger* territory; *i. e.*, a curve which will indicate all points of the system where the most damaging influences exist.

The *Fifteenth* and last paragraph requires that these regulations should be observed, not only when the railway is first installed, but constantly observed during the operation of the road. This assures that the required conditions are permanently maintained, and that improper conditions, due to changes in the traffic and in the distribution of the load, or owing to increased resistance in the track system or other causes, cannot exist unnoticed for any considerable time.

Report[1] of the Electrolysis Commission of the German Society of Gas and Water Engineers in 1905.

The following is a report of the work carried out during the year from June, 1904, to June, 1905:

1. *Programme of the Work.*—As is seen from last year's report the Commission concluded that the principal cause of earth currents, and with these the possibility of severe and rapid electrolytic destruction of pipes, is the unsuitable conditions of return circuits in electric tramways. Hence the Commission's first task was to investigate the electrical conditions of the pipes and rails in various characteristic towns, and, where necessary, to find means to limit the danger of the earth currents as much as practicable. The task was, therefore, primarily an electro-technical one. The following necessary preparations were made during the previous year:

1. Collection of current information from the managers of the different gas, water, and electrical works, by means of a circular letter containing a detailed set of questions.

2. Development and testing of methods of investigation.

3. Tabulation of rules, for temporary guidance, developed from previous experience and especially from the results obtained at Elberfeld where the first investigations were carried out last year.

It was intended, after preparation, to continue these investigations this year in other towns, in order to collect as complete a set of experimental facts as possible.

2. *Choice of Places of Investigation.*—In selecting the places for electrolysis investigation those were considered in which the installations promised characteristic results, or where unusually severe corrosion had occurred and a thorough investigation seemed, therefore, desirable to clear up questions of general importance and to promote local interests. Also, places were considered where the authorities, realizing the importance of this work, had applied to the Commission for information regarding the condition of their pipes, and of the means available for removing or diminishing any existing danger. At the following towns tests have either been completed, or are still partly in progress, or negotiations for such tests have been begun:

Strasburg, where corrosion of the water pipes had been observed and an investigation was desired by the municipal authorities.

Dresden, where particularly interesting and instructive conditions were to be expected, owing to the use of bare return conductors.

Leipzig and *Hamburg*, where rules for the protection of the pipes were in force, which were in many respects similar or equivalent to the regulations of the Commission, so that such tests promised to determine the effectiveness of these protective measures.

Erfurt, where particularly severe corrosion of gas pipes had occurred.

Freiburg in B., where the management of the municipal gas, water, and electrical works requested the Commission to test the return conductors and pipes, although no corrosion had yet been noticed.

The resumption of the work was delayed until the end of November, 1904, owing to the resignation of the engineer, Mr. Max Spindler, who had carried on the preparations and investigations at Elberfeld last year. This made it necessary to secure in his place Mr. Friedrich Besig, who was not free to serve the Commission until that time.

Strasburg was chosen as the first place for investigation; work was begun there at beginning of December, 1904, and lasted about 8 weeks. Dresden followed Strasburg, and here the investigations occupied about the same time. The discovery of corrosion at Strasburg some time later induced the municipal authorities to apply again to the Commission, which accordingly sent its engineer to Strasburg for a second time in search of new developments.

3. Principal Results of the Investigations at Strasburg and Dresden.

The results are collected in two detailed reports, with drawings and diagrams, and were communicated to the board of the Society and to the administrations of the towns concerned. The reports, with all the appended drawings, are too extensive, however, for immediate publication. The work of the Commission, when completed, will be published in detailed and collected form; but only the principal results of these researches can be given at the present time.

(a) *Tests at Strasburg.*—The voltage measurements in the network of pipes and rails showed abnormally high maximum values. These were:

Close to the generating station an average of 2.2 volts (periodically) and a maximum of 2.8 volts between the pipes and rails, the pipe being positive relative to the rails. At a great distance from the station, there was an average of 4 volts and a maximum of 11.5 volts, the pipe being negative relative to the rails. The important direct measurements of the potential differences between the connection points where the return conductors are connected to the rails could not be made for want of a sufficient number of test wires between these points and the central station. The return conductors were, it is true, provided with test wires, but nearly all of these were useless in consequence of breakage or of failure of the insulation. This again proves with what little consideration the return conductors have been treated by many electric railways, and how important it is to draw their attention to this point.

In making such tests the lack of suitable controlling arrangements is unpleasantly felt. Much time is consequently wasted, and it is necessary to employ indirect methods of testing, which are much less accurate than direct voltage measurements. At Strasburg the strength of the current in the return conductors was measured, and the resistances of these lines were calculated from the sections and lengths which were furnished by the authorities. The product of the current and the resistance of the line give the drop in voltage, and the differences in the drops of the individual return lines give the potential differences between the various connection points.

According to the protective regulations laid down in 1904 (rule 6, p. 139), these differences should be practically nil; at Strasburg, however, under the existing conditions, these differences reached 6.5 volts. This unfavorable result is not a consequence of insufficient return lines nor of insufficient cable cross section. The return wires have in fact the same cross section as the outgoing supply wires, and they are connected to the rails at all points where the outgoing wires are connected to the trolley wire. (This arrangement is often chosen because it makes it possible to replace temporarily the positive feeder cable by the return cable in case of defective insulation.)

The result mentioned is, in this case, due to the lack of the proper relation between the resistance of the individual return cables and the current which they carry, and is especially due to the short and large return conductor of very low resistance which connects a point close to the central station directly to the negative busbar.

Currents up to 1 ampere were measured at several places in the pipes; these occurred only during the operation of the electric traction service and were, therefore, tramway return currents. Under suitable conditions of current density and soil such currents will cause considerable corrosion where they leave the pipes.

A clear impression of the efficacy of the return lines was obtained by measuring the current in the single return lines simultaneously with the current in the corresponding supply wires. It was found that although the currents in several of the return lines varied little from those in the outgoing lines, which is generally speaking the normal and suitable condition, yet in the very long and very short cables extreme differences between return and outgoing currents were observed. In the longest return cable the current was found to be less than $\frac{1}{4}$, while in the shortest return cable it was found to be more than 4 times the corresponding outgoing current.

This corresponds with the extreme differences of pot ential between the connection points of the return conductors. If a return connection point remote from the central station has a higher potential than one close to the station, the current from the remote section will be returned only in part through the long return conductor, the other part being returned by the rails and the ground to points of low potential near the central station.

The rail bonds in the Strasburg system were examined at a number of points by means of the bond testing apparatus. This showed that the percentage increase of resistance of the rails due to the bonds varies considerably, in some cases up to 100 per cent. The bonds made by the thermite process of Dr. Goldschmidt and those electrically welded (though in use only a short time) gave good results, as their resistance in many cases was practically equal to that of the continuous rail.

An important result of the Strasburg experiment was the confirmation

1. Condensed translation.

of the value of rule 6 of the protective regulations regarding the equalization of the potentials at the return connection points. By simply inserting a small resistance in the shortest return cable, the maximum difference of potential between two return connection points was immediately reduced from 6.5 to 2.8 volts, and the difference of potential between the pipes and the rails was reduced in the whole system to an average of about ½ of the former amount.

This method is without doubt particularly effective; and, by inserting variable resistances in all the return lines and testing and adjusting at regular intervals, conditions can be secured in the Strasburg pipes which will cause the present unfavorable differences of potential to disappear, and reduce the danger of the corrosive action of the tramway return currents to a small amount.

A careful observance of these suggestions is particularly important in the case of Strasburg, because the nature of the soil and high level of the ground water appear to favor the conductivity and electrolytic action of the ground.

The special electro-chemical researches which are being made with reference to this last feature have not yet been completed, and the Commission will give further information on this point in the next report.

b. Tests at Dresden.—The experiences gathered in Strasburg apply in many respects to Dresden. In this case also the return wires were connected to the rails close to the electric power station. As there are, however, 2 central stations supplying current, the distribution of the potential differences between the pipes and the rails differs in its graphical appaarance from that observed in Strasburg and Elberfeld, but is the same in principle. In Dresden there are two regions of lowest potential, one in the neighborhood of each central station, where the potential of the pipes is higher than the potential of the rails; these are, therefore, danger zones for the pipes.

The main difference between the return line installations at Dresden and those at Elberfeld and Strasburg lies in the use of uninsulated return wires, which although cheaper are not as effective for the protection of the pipes as are insulated return wires.

An insulated conductor laid in the ground is in contact with the ground along its entire length and imparts its own potential to the ground; the 2, therefore, behave like 2 electric conductors connected in parallel at an infinite number of points. Hence, the drop in potential, with the practically perfect contact existing, must be nearly the same in the soil surrounding the cable as along the cable itself.

The uninsulated return conductors in Dresden are, as a matter of fact, placed in a brick conduit which is filled with earth. This brickwork is, however, not watertight, many bricks having been broken during construction, and the moisture of the ground easily penetrates this conduit, making a good conductor at many points between the layers of soil inside and outside of the conduit.

In this way the rails, the return cable, and the soil form 3 parallel conductors between which the return current divides in proportion to their conductivities. While, then, the main function of the return conductors should be to lead off all the currents which come together at the point of connection to the rails, in Dresden they serve, notwithstanding the high conductivity of copper, only to slightly increase the rail section, on account of their small cross section as compared to that of the rails. This is particularly the case in those districts where the return cables run parallel to the rails for long stretches (as with almost all of the Dresden lines), and are especially well-connected electrically to the rails about every 300 feet. Therefore, the Dresden return cables do not prevent what they are intended to prevent—a gradual increase in the current returned by the rails from the ends of the system to the central station and a corresponding parabolic increase in the fall of potential along the rails. The result is that, in the vicinity of the central station, even with excellent rail bonding, large differences of potential are certain to occur in the rails, and for this reason also in the soil and pipes. In this way the potential differences in the rails in Dresden gradually increase from 0 to about 5 volts per kilometer of the rail length.

The differences in potential, and hence the currents in the pipes, increase in a similar manner. Several pipes carry very large currents; for instance, a trunk gas pipe carried about 4 amperes. This unusually large return current is explained by the fact that Dresden is separated into 2 separate systems of street pipes by the Elbe. Since both central stations are located in the district on the left side of the Elbe, all of the stray currents which enter the pipes in the district on the right bank collect in the few trunk pipes which cross the Elbe.

The largest potential differences, between pipes and rails of the dangerous kind, *i. e.*, where the pipes are positive to the rails, occur in the vicinity of the central stations close to the connection points of the return lines, as well as near the short, uninsulated return wires which connect with the negative bus-bars in the stations. These amount to about 3 volts.

Corrosion has hitherto been noticed only in lead, house service connections which cross the rails, and this corrosion is confined to the immediate vicinity of the old power plant which exists since 1893. In the neighborhood of the new power station, put in operation in 1900, nothing conspicuous has been noticed up to date. The uninsulated lead pipes apparently form a good conductor which lead off the current from the soil and in this way protect to a certain degree the iron pipes. Traces of corrosion on these latter were also, however, observed when a pipe was exposed in order to measure its resistance; these pipes, too, were close to the older power plant.

The pipes in Dresden as well as those in Strasburg were also tested during the night. The potential differences and currents (natural earth currents and those caused by local action) which were observed when the tram service was suspended, were negligibly small compared to those observed when the tram service was in operation.

In Dresden, also, the auxiliary test wires were insufficient to measure the potentials at the connected points of the return conductors. Moreover, only a slight improvement over the dangerous condition at Dresden can be accomplished by adjusting the uninsulated return lines; for even if by this means a uniform potential at all of the connecting points of the return lines is secured, the leaking of the current from the uninsulated cable to the soil and its re-entrance into the cable at suitable places cannot be prevented. The substitution of insulated lines for the uninsulated ones is the only remedy. Some insulated return conductors have recently been installed in Dresden.

4.—Measuring Methods and Instruments.

There is scarcely anything new to be added in this respect to what was given in last year's report. The experiences in Strasburg and Dresden show that the methods worked out and tested in Elberfeld can be conveniently used, and that the results obtained indicate with great certainty the location of districts endangered by earth currents. Two new, large instruments were purchased during the year; viz., 1 recording ampere meter and 1 bond tester.

The recording instrument serves especially to determine the average values of the currents in the return and feeder cables. It is provided with a clockwork which can be set for different time intervals varying from 6 minutes to 6 hours, so that the variations occurring during a long period, as well as the characteristic variations of the tram service, can be clearly observed. The electric part of this instrument depends, as in the case of the others, upon the principle of the Deprez-D'Arsonvalle instruments; *i. e.*, the motion of the pointer is produced by a movable coil suspended in a permanent magnetic field. This instrument can be used directly as a voltmeter, and by the addition of shunts as an ampere meter.

The bond tester consists of 2 rods for making contact, and of a very sensitive differential galvanometer which also operates on the moving coil principle. One of these contact rods is constructed as a double contact, and serves to connect the galvanometer with the two ends of the rail joint, while the second contact rod, which is also connected to the galvanometer, is moved on the rail during the measurement until the galvanometer needle is on zero. Then the drop, due to the rail joint, in the voltage of the tramway current (or when the service is suspended in a current lead to the rails from an auxiliary battery), is equal to the drop in voltage of the same current in the continuous length of rail between 1 of the double contacts and the variable single contact rod.

Thus, the resistance of the rail joint is not given in absolute ohms, but in terms of the resistance of the continuous rail. If the normal rail length is known, the increase in the resistance of the rail due to the joints can then be calculated directly.

5. New Points of View.

A new case of corrosion with the indications usual in electrolysis induced the management of the Strasburg water works to call upon the Commission a second time, as already stated, and a supplementary investigation was, therefore, made at that place.

A 4-inch water pipe which had been in the ground for about 30 years was corroded, for a length of about 500 feet, to such an extent that it was necessary to replace it with a new pipe. Since previous measurements of potential differences between the pipes and rails made at this point indicated the latter to be in a neutral zone, that is, neither a danger zone nor a protected zone, it seemed unlikely that a large amount of return current escaped from the pipe to the rails at the time the measurements were made. It was thought, therefore, either that an escape of current from the pipe in the earth, but not into the rails,

had been brought about by increased resistance of pipe joints and destruction of the protective coating, in conjunction with good conducting soil (possibly ground water leading toward a connection point near the central station); or else that the damage might have been done at a former time when the return circuit conditions of the road were different, so that there was possibly a danger zone at this spot.

The first assumption is supported by the fact that the surface water is relatively high at this point, so that the conductivity of the soil is increased; and several of the socket joints were actually found to be leaking. Besides this, the river Ill is in the immediate vicinity of the line and flows close by the central station, so that earth return currents would find in this way a good return path to the central station. The second assumption is supported by the fact that another pipe, just as old as the damaged one and connected to it, but lying in a parallel street where there are no tracks and where similar soil exists, has not shown such corrosion. Besides, by far the largest and most numerous corrosion pitholes were found on the side of the pipe facing the tracks, instead of being uniformly distributed around the whole pipe.

The measurements of potential and current which were repeated at this spot only confirmed, however, the previous measurements, and showed that the currents flowing through the pipe at this point, following the fluctuations of the operation of the tram system, are so small that the danger to the pipes cannot be considered to come from this cause. It is to be noted that the old 4-inch main had, in the meantime, been replaced by a new 6-inch one; but it is not probable that the electrical conditions were appreciably affected thereby. This case may be considered, therefore, to represent a particular type of corrosion, and is generally important in the solution of the electrolysis problem. Moreover, the municipal authorities were anxious to ascertain, if possible, the cause of the corrosion; so that it seemed desirable to follow up the case from the standpoint of chemistry and electrochemistry. The questions involved can be put into the following form:

Can iron be thus corroded in such soil without the action of external forces (rail return currents or the like)? If so, can the phenomena be observed on the spot? Are there purely local actions present during the corrosion, such as electromotive forces and polarization voltages, which can be determined qualitatively without error and measured quantitatively with sufficient accuracy?

A solution of this problem requires a thorough chemical analysis of the soil, besides a practical method with proper ground contacts for for determining the polarization voltages. The metallic contacts formerly used become polarized even in the ground, and under certain circumstances lead to fictitious results when used for the measurement of the potential of the soil. Since, however, no one appears to have used suitable electrodes, further experience must be collected. It will be also necessary to learn how iron will act electro-chemically in such solutions of salt as occur in the soil.

In making such researches the co-operation of a chemist and an electro-chemist with especial experience in this work is desirable. The preliminary experiments have already been started with the co-operation of experienced specialists.

6.—Future Procedure.

It is intended for the present to continue the work in the same way as previously; that is, to collect further material from the electrical field, and also to pursue the study of the chemical and electro-chemical features, so as to determine all of the conditions which produce danger from corrosion. In this connection, it is proposed particularly to make experiments at several characteristic places without electric tram systems, where pipes have laid a long time in soil where chemical and electro-chemical actions may be expected.

W. H. Lindley, Chairman,
Frankfort-on-Main, May 29, 1905. Electrolysis Commission.

SECTION V.—SUMMARY AND CONCLUSIONS.

General Summary.

In the normal operation of an electric railway using the rails for the return circuit, the current (and, therefore, the potential) in the rails is increased progressively by each car tnat discharges into the rails. Hence, where the rails are the only return conductors, the potential therein increases both with the number of cars and with the distance from the power station; and the maximum potential difference in the rails is the drop in potential (due to the resistance of the rails) between the furthermost car on the line and the power station.

It is a popular mistake to say that electricity follows the path of least resistance. Electricity follows all paths open to it, and divides itself directly as the conductivity of the various paths. Consequently, whenever and wherever there is a difference of potential between 2 grounded points of a conductor, as is always the case where grounded rails convey return tramway currents, some current will flow through the ground and along the pipes buried in the ground.

With the composition of soil usual in city streets, it is generally agreed that the smallest direct currents will cause electrolytic corrosion where they pass from the pipes into the ground, and an attempt is sometimes made to gauge such damage by measuring the flow of current in the pipes and ascribing a destructive effect of 20 pounds of iron or 74 pounds of lead to each ampere year. Assuming the accuracy of this relation, it should be understood that this annual destruction of 20 or 74 pounds, respectively, per ampere of current, occurs wherever the current passes from the pipe into the ground, as there is no limit to the number of times that the same current may leave and re-enter the pipes there appears to be no theoretical limit to the destructive power of a single ampere of direct current. Likewise direct currents, very much smaller than 1 ampere, may in time produce wide destruction.

Since every electric railway with uninsulated returns will produce stray currents, and since these stray currents will inevitably cause electrolytic damage to neighboring pipes and other subterranean metal wherever the current passes from the metal into the street soil, it follows that the only ways to prevent such electrolytic damage are:

1. To stop the use of uninsulated returns and the consequent escape of stray current; or,
2. To prevent any of the current which strays to the pipes or other metal from again entering the ground.

The first remedy (1), which is fundamental and absolute in character, is completely attained by the use of double trolleys, either underground as in New York and Washington, or overhead as in Cincinnati and the District of Columbia; or, in special cases, by effective insulation of the rails themselves. The difficulty in this case is that such prevention of stray currents depends solely upon the traction company, and can be enforced only in the rare event of there being effective provisions to that end in the traction franchise or by protracted process of law. On the other hand, the second remedy (2) lies largely within the scope and power of the gas and water undertakings, and relief of this nature is, therefore, frequently attempted by connecting the street pipes with the electric circuit in various ways and places.

As this kind of remedy (2) has been applied upon an extraordinary scale in Chicago (see pages 58 to 61), and in Detroit (see pages 61 to 70), a discussion of one of these cases will cover all other and minor attempts at relief of this character.

The Chicago work was based upon the usual electrical survey, which divides the pipe system into 3 districts, classified as follows:

1. The large "negative" district (where stray current is flowing from the rails to the pipes), which has been considered immune.
2. The smaller "positive" district (where the accumulated stray current is returning from the pipes to the rails), which has been considered the endangered district requiring protection.
3. The so-called "neutral" or intermediate district, which is alternately negative or positive, according to the distribution and loading of the cars, the state of the track and rail bonding, the weather, soil and other conditions.

Upon the supposition that electrolytic damage is practically confined to the positive district, the most comprehensive efforts possible were made to eliminate this positive condition from the Chicago gas pipes, and to make the whole system of gas piping negative to the rails. To this end, every pipe joint in the positive district was thoroughly bonded with copper, and return feeders were brought from various points of the pipes to the negative busbar, which converted the gas piping into a better conductor than the rails themselves. This, of course, vastly increased the current on the pipes in the former positive and intermediate districts, and correspondingly increased the flow along the pipes in the negative district.

Now, in the opinion of your Committee, the dangers and liabilities attaching to this great increase of current throughout the piping system form a serious objection to any remedial scheme of this kind—quite apart from its obvious expense and difficulty of application and maintenance. Moreover, as a remedy for electrolysis, this plan is founded upon an erroneous premise, viz., that electrolytic damage is confined to pipes that are positive to the rails.

Since electricity flows along the negative and intermediate as well as the positive pipes, the latter proposition is equivalent to maintaining that no current can leave the pipes *except to return to the rails*, But it is evident, and experience has amply confirmed, that the current on the negative pipes will shunt proportionately every pipe joint which introduces additional resistance, and will pass from one pipe or con-

ductor to every other of lower potential—resulting eventually in electrolytic destruction at these joints and places.

In the case of negative water pipes there is evidence that many of the joint leaks, leading to ultimate breakage and flood, have their origin in electrolysis; and your Committee is satisfied that the comparative absence, in the past, of external evidence of electrolytic destruction at the joints of negative gas pipes is due more to the reduced strength of the currents diffused throughout these large areas than to the negative condition of the pipes. In other words, with these small currents, the rate of destruction is proportionately reduced, and the time is correspondingly deferred when the external evidence of completed destruction will eventually assert itself.

In Chicago and in Detroit, however, the great increase of current in the pipes, resulting from the remedial scheme, tends to create in the former intermediate and negative districts conditions which, considering the greater areas involved, may ultimately prove to be worse than the original trouble in the positive districts. In Detroit, a single 12-inch, wrought iron gas pipe was found to be carrying at times a current of 3,600 amperes and lead joints in cast iron pipes have been actually melted by the current!

Furthermore, every addition or change in location of a power station or sub-station, and every return feeder connected with the rails, creates a new positive zone and requires a corresponding change in the pipe return circuit. Likewise, every break in a pipe or rail bond, and every change in the conductivity of piping or rails, will upset the return conditions.

Finally, there is manifest legal objection to any action which enormously increases the currents straying from the rails, and changes their distribution. Gas pipes are not the only tenants of the streets exposed to electrolysis. For example, water and gas pipes and services are everywhere interlaced; and if these water pipes, which were formerly positive to the rails only, are made still more positive to the interlaced gas piping by the bonding of the latter to the negative pole, a greatly increased current will pass along and from the water pipes into the gas pipes, causing proportionately greater damage to the water pipes from electrolysis. This unauthorized use of street piping for the return electric circuit, if of damage to others, can doubtless be prohibited by law, thus nullifying the large investment to that end, apart from any question of liability for the damage caused. Hence, it appears that a pipe return system, even when applied upon a scale so expensive as to be generally prohibitive, affords but temporary and uncertain relief in the positive district, and greatly increases the danger from electrolysis in the negative and intermediate areas, especially at the joints of the pipes.

Continuous lead cable sheaths, which are of small and homogeneous section, with high and *uniform* resistance, have been connected to the negative bus-bars with apparently satisfactory results, as far as the protection of the lead itself is concerned; but your Committee entertains no hope of preventing electrolytic damage to heterogeneous networks of street piping by any so-called protective method which encourages an increased flow of stray currents to and along the pipes. On the contrary, your Committee is convinced that the only practical way of preventing electrolysis of street piping is to prevent the escape of stray currents by the use of a completely insulated circuit.

That is the logical solution of the electrolysis problem, and the natural way to secure this result is by proper stipulations in the traction franchise. Such stipulations, however, cannot be readily interpolated into existing franchises; hence, legal action must be generally relied upon to prevent the discharge of a destructive agent into the streets.

While little encouragement can be drawn from the Peoria and Dayton litigation, it should be remembered that the *demonstrable* damage caused by electrolysis is accumulating continuously, while the ineffectiveness of the various protective measures is being continually demonstrated; thus, the legal espect of the problem grows always stronger, and must soon become overwhelming.

Of the various plans for *mitigating* electrolytic destruction, your Committee indorses only those which aim to reduce the stray currents by decreasing the maximum difference of potential between 2 points of the return rails, and by increasing the resistance between the rails and the pipes. The British regulations, although utterly insufficient in character and degree, are directed toward this end; and it is this general method which the German Commission are testing. It may be here noted, however, that foreign conclusions must be applied with caution to the unique conditions existing in American cities, where electric traction is now practically the sole means of local transit and is used upon a scale and under a pressure of traffic generally unknown in foreign countries.

The proper application of this ameliorating method requires the thorough and permanent bonding of all rail joints and the cross bonding of both rails and tracks at frequent intervals, and also such construction of the rail foundations and road bed as will increase as much as practicable the resistance between the rails and the ground. Then the rail network must be divided into suitable sections by separate return feeders, which sections of rails and return feeders should be so proportioned or regulated that the potentials at the return connection points are practically equalized.

Parenthetically, the German Commission are not always quite clear in their reasons for equalizing these potentials. *Given a fixed limit to the difference of potential in the rails*, there appears to be no reason why inequality of potentials at the connection points should seriously increase the electrolytic damage; it might have even the opposite effect; but, on the other hand, it is absolutely essential to an efficient tramway service *at the minimum potential difference* in the rails that these potentials at the return connections be practically equalized; otherwise, the effective potential difference in certain sections of the track will be reduced below this minimum working limit, and the service thereby disorganized.

The return connection points, if thus equalized, are virtually substations, which divide the rail network so that the maximum difference of potential in the whole system is the maximum drop in any one section. The more numerous these connections and the shorter the sections, the less manifestly becomes the maximum potential difference in the rails, and, other things being equal, the consequent escape of stray current. Hence, if these divisional conductors be multiplied indefinitely, and if the potential equilibrium of the various sections be continuously maintained by proper adjustment, the difference of potential and consequent straying of current may be reduced to such a degree that electrolytic damage will become practically negligible. But, instead of trying to carry this purely mitigating system to the ultimate and impossible limit of prevention, it is obviously preferable to destroy the root and branch of the whole electrolysis evil by using an insulated (return) circuit.

In this connection, it will be remarked that the German Electrolysis Commission have not once referred to the desirability or possibility of confining the tramway current to a completely insulated circuit, thereby *preventing stray currents*. They have, on the contrary, devoted themselves exclusively to the *mitigation* of electrolytic destruction, by formulating all kinds of ways and means for reducing the strength of the stray currents. Yet, notwithstanding the great expense and difficulty of applying and maintaining their exhaustive precautionary regulations, they find it necessary to supplement these comprehensive measures by recommending that the present maximum permissible potential difference in the network of rails be limited to *one volt!*

In other words, an effective method of minimizing the stray currents is so elaborate, and at the same time so restricted, that a single insulated circuit seems preferable, even on the score of simplicity and cost, without regard to the all-important fact that the German regulations merely *mitigate* an evil, which the insulated circuit *completely eliminates*. Your Committee, therefore, feels that the German experience does not yet shed any encouraging light upon electrolytic conditions, but on the contrary tends to emphasize the advantages of the double trolley system.

It is also worth noting that, while the reasonable use of return feeders will greatly reduce the potential difference in the rails, it tends to multiply the number of endangered areas by creating a positive zone about each return connection. Moreover, although the quantity of stray current is dependent upon the difference of potential in the rails, it by no means depends solely upon this difference; the conductivity of the soil and of the materials in and tenanting the soil exerts an equal influence.

Your Committee disapproves of the indiscriminate use of insulated pipe joints in the hope of preventing a flow of electricity along the pipes. In some places this plan will prove useful; but without proper selection and precaution it is likely to do more harm than good, inasmuch as the reduced pipe current must leave and re-enter the pipe at each insulated joint, thereby multiplying its destructive effect. It follows that electrolytic damage to any system of street piping may be considerably influenced by the kind of pipe joint adopted—whether lead, cement, machined or gasket.

Finally, it should be remembered that the underground piping and other metals employed in the larger cities not only represent original investments of great magnitude, but apart from the danger to life and property attaching to any escape of gas or flood of water (or conflagration in default of water), the repair and renewal of these pipes and metal are made far more costly by modern street pavements and traffic

—not to speak of the loss and inconvenience caused to modern communities by the continual disruption of streets and sidewalks.

CONCLUSIONS.

In view of the state of the art of electric traction, as set forth in the foregoing pages, your Committee unanimously concludes:

First.—Electric railways should be held responsible, by the terms of their franchise, for all damage to others engaged in the discharge of franchise obligations or in any lawful pursuit or occupation, caused by their overt failure to control their own currents.

Second.—The immunity of street piping and other metal in centers of population from electrolytic damage due to stray currents demands that electric railways shall employ in such districts completely insulated metallic circuits for all currents; and such railways may be especially exempted by ordinance from responsibility regarding electrolysis, *so long as they effectively maintain such circuits.*

Third.—In small communities where local conditions are favorable, or wherever the property liable to electrolytic damage is of minor value, the rails may be used for the return current, *subject to Clause First*, provided:

(1) The potential difference in the rails be sufficiently[1] reduced by properly balanced return feeders and thorough bonding.

(2) The rail foundations be constructed to increase as much as practicable the resistance between the rails and earth; and

(3) There be proper supervision to insure conformance with these requirements.

Fourth.—In rural districts, or wherever no property is liable to electrolytic corrosion, the uninsulated rails may be used *per se* for the return current. Respectfully submitted,

A. G. GLASGOW, Chairman,
JOHN WILLIAMSON,
S. P. CURTIS,
ARTHUR H. HALL,
} Committee on Electrolysis.

Prof. ALBERT F. GANZ, M.E.,
Consulting Electrical Engineer to the Committee.

1. Your Committee cannot indicate suitable local voltages, but it has been seen that the German Commission commend a present maximum potential difference of *one volt*.

"More Gas."—A Little Talk on the Advertising End of the Gas Industry.

[A paper read by MR. C. W. LEE, Newark, N. J., at the January meeting of the National Commercial Gas Association.]

In his talk this morning Mr. Kenyon referred to salesmanship as a science. Now, there is such a thing as science in advertising—in fact, the right kind of advertising is salesmanship on paper, which, coupled with individual salesmanship (especially in the gas industry), will produce more efficient results. Mr. Kenyon also told you of the individual unit; how every piece of gas advertising should be a unit, carrying with it power to persuade the buying public. Through advertising the confidence of the public can be gained and held.

At the outset, I had planned to preface this talk with a series of stereopticon views, showing the various forms of advertising in vogue with up-to-date gas companies, this series to include pamphlets, booklets, periodicals, follow-up campaigns, display rooms, etc., but the arrangement of this auditorium would not permit of the fulfilment of such a plan.

Concrete examples of modern gas advertising were fully covered in the book issued on "New Business Methods," to the American Gas Institute, October, 1906, by Mr. George Williams, which book should be upon the desk of every commercial man.

There is plenty of good advertising as well as quantities of bad advertising done by gas companies to-day. Possibly no advertising is too bad to produce some results, but altogether too much of the advertising prevalent now is of negative quality, yet the space which it occupies costs hard cash. The other day I picked up a newspaper, carrying this advertisement of a gas company:

"GAS HEATERS,
GAS RANGES,
GAS PORTABLE LAMPS,
GAS LIGHTING."

An advertisement of this character is simply a space filler, and cannot be productive of results. It means absolutely nothing to the prospective buyer. Some gas managers look upon advertising as a necessary evil; they spend money on it spasmodically and injudiciously; buy newspaper space for the sake of policy, or just because the newspaper man is a "good fellow," or a good talker. This is done without any regard to the business-bringing value of the space, which could with but little concentration and effort be made a constant business-getter.

In the organization of a new business department it is essential to insure the best results, that a very careful list of prospective customers be produced. To do this a census of the town or city must be made, not from a directory, but by house-to-house canvass. This census should cover buildings and dwellings, as well as families in city. It should also carry information concerning services installed, lighting customers, meters in service, ranges installed, dwellings on line of mains not using gas, and buildings not on line of mains. From such a census the prospect list can be arranged, by a simple but efficient card system, either into districts or by streets. The manager of the commercial department should at all times have this list under control. He should require a daily report from the solicitors on the prospects visited, and the result of this campaign should be entered upon the cards. By this method, in the event of illness or discharge of the solicitor, the work can be taken up without any trouble by new men.

Then, the advertising, which is by its very nature secondary to the soliciting force, should be carefully planned to meet the local conditions. By making this advertising efficient, the calls of the solicitor can be greatly reduced, thereby increasing the possibilities in volume of business.

Advertising must be divided into two classes: Specific and general. Specific advertising consists of direct-by-mail and house-to-house distribution of pamphlets, letters, etc., while under the general advertising head may be classed newspapers, bill boards, street car advertising and programmes. The best results in the gas field have been obtained by the use of specific advertising; that is, by reaching the prospect directly. Advertising of this character paves the way and is first aid to the solicitor. This method, augmented by strong newspaper copy, is bound to bring effective results.

Some managers seem to have an idea that it is only necessary to *plan* an advertising campaign, and that the business will then take care of itself, but persistency and perseverance are as necessary in the commercial gas field as in any other line of business. Advertising is the assistant, not the general manager, in the business-getting company.

Mr. Frank Frueauff, of the Denver Gas and Electric Company, writing upon "Business Getting Methods," gives this salient advice:

"To much attention cannot be given by the representative to the complaints, either real or imaginary, which come to his notice. One dissatisfied consumer in a district can undo weeks of work of the most capable representative, and the satisfactory adjustment of a complaint has often resulted in an order, and has made the consumer an active solicitor for the company. The sending of letters to prospective customers, unless followed up within a reasonable time by a trained solicitor, cannot be expected to accomplish results. Many people are in a receptive mood after reading advertising matter, and if we can call and see them soon after we can get their business, but they will not take the trouble to look for the man who has it to sell. This applies in every line of business, and probably more so in ours than with the so-called retail establishments. One of the very important features in the getting of new business is in the persistency maintained by the company. We can hardly hope to secure results that would justify any part of the expense of a new business campaign unless it is followed up persistently and systematically."

Furthermore, I believe it is a serious mistake for gas companies to sell either domestic or industrial fuel appliances at or below cost. By the right kind of advertising and soliciting methods, a nominal profit can be made upon appliances without decreasing the output. Of course, you say, you are interested in the sale of gas, not appliances; but why not make a profit upon the mercantile end of the business?

There is real advertising value in a properly lighted and well arranged display window and show room, showing appliances and fixtures in operation, which cannot afford to be overlooked. I stepped from the train in a city of about 50,000 inhabitants, a few weeks ago, at 5:30 P.M., and inquired the way to the gas office. I was directed down a brilliantly lighted block—with a Nernst lamp suspended in front of every business place—to the opposite corner. There was the gas office. Its window curtains were drawn, and there was no sign of light or life anywhere. *That* gas manager is derelict in his duty to the public and to his company.

Another gas manager in a city of 100,000, in speaking of new business development, said: "Why, we have sold 400 ranges this season. That is a very good record, don't you think?" I told him very frankly that I did not think it was a good record and that in such a live town he should be selling 4,000 rather than 400 ranges a year. He had the wrong viewpoint.

The lack of confidence, coupled with inexperience in the art of advertising, has caused failures to those gas managers who have tried and then abandoned this method of securing additional customers.

The aim of all advertising is to aid in the selling of something. If it does not accomplish this it has failed in its mission, and the money expended in the endeavor is lost. The preparation of advertising matter

is an all-important element. It deserves time, thought, study and, most of all, practical experience.

In the midst of the thousand-and-one details of managing your business, you probably have not the time nor inclination to concentrate your mind on the preparation of "copy." If that be the case, call in the advertising specialist. Good copy is the vital spark of advertising. Advertising that lacks the elements of salesmanship is an extravagant waste of money. No matter how inexpensive the mail card or folder you use, if it is not selling your goods, or assisting, it is a loss, and the opportunities it possessed are gone forever.

Advertising does not consist of merely printing handsome booklets or other pieces of literature, but in the proper distribution of such matter. I can take you in storerooms throughout the country and show you thousands upon thousands of manufacturers' booklets and catalogues covered thick with dust, which have never been distributed. That state of things is not fair to the company, nor is it fair to the manufacturers of appliances. If these booklets have any value whatever, why not distribute them? If they have not, do not place an excessive order with the manufacturer or the printer.

Some manufacturers have adopted the policy of developing local fields by distributing their own printed matter, putting their own men in the field and then following it up consistently. I know of several manufacturers, who by such a policy have increased their sales over 50 per cent. during the past season.

Many boards of directors are pursuing the policy of retrenchment, refraining from investing in new equipment and making main extensions. When a policy of this kind is determined upon, it becomes necessary for the commercial man to develop the field along the line of his present mains.

Recently I had a conference with a gas manager in a large city, who stated their company had upon the books 12,000 non paying customers—consumers not using a minimum quantity of gas. It is with this class of consumers that educational advertising can be used to material advantage.

There is now a movement on foot, among the leading gas companies, to adopt publicity methods. By this I do not mean regular advertising, but a form of newspaper publicity, showing the policy of the company; what it is expending and has expended in improvements; the efforts it is putting forth to give good service and the advance of other cogent reasons discountenancing the chronic cry against high gas bills. These publicity methods are proving most successful.

Let your efforts be persistent, never for an instant stopping, and remember that it is only by keeping everlastingly at it that gas sales are increased and success ultimately assured.

This paper was not written with any idea of being a treatise on gas advertising. Rather, it was outlined simply to oall forth a general discussion upon the advertising proposition. I, for one, would be pleased to hear of novel as well as ordinary methods now in vogue for securing new business through advertising.

[Translated for the JOURNAL by MR. FREDERIC EGNER.]

The Vertical Retort Oven and the Future of Gas Making.[1] No. I.

By DIRECTOR EISELE, of Cassel, Germany.

Only a few months before his untimely death our colleague, Herr Emil Merz, communicated to the members of the German Gas and Water Business Men's Association, at the annual meeting, Darmstadt, 1903, certain data concerning endeavors in the field of gas manufacture.

At that time he touched briefly upon the subject of charging, drawing and pushing machines, which then had only been known a short time, saying that one was as yet obliged to await results before passing judgment upon these machines, which indeed was confirmed and manifested at the recent meeting in Bremen, when these machines were so variedly commented upon. He also mentioned at the time the efforts being made then, with the "Great Chamber" ovens at the Munich gas works, and by the Riepe Company at Brunswick, to obtain better results, and especially in respect to producing the largest volume of gas in the least possible area of space. Although, according to his own showing, he did not consider these attempts to have been genuinely successful, he himself had experimented at Cassel with an arrangement which was something between a "retort" and "chamber" oven, in the course of the operation of which this apparatus yielded results practically in accordance with its character, or averaging between the known results of the "retort" and the "chamber ovens." That is to say, the yield of gas per unit of coal and space was not greater, but less than with the old retorts; on the other hand, the coke was decidedly better, harder and denser. That oven is still in operation and has kept up very well to date. Continuing, Mr. Merz mentioned two of Murdoch's forms of construction of retorts in the infancy of the gas industry—two vertical retorts made of tiles in the year 1812—thereby showing that at the very beginning the vertical retort had been regarded as the most natural form, wherefore to return to this long-ago tried vertical retort was the latest aim of gas technique. The vertical gas retort, with side take-off, at the time only proposed by Dr. Bueb, of Dessau, and the Settle-Padfield retort, were shown by sketches and explained by Herr Merz at that meeting. In the course of the discussion that followed I gave it as my opinion then, that, when considering the object and value of vertical retorts, I was not looking forward to a saving of floor area (which appeared to be the case with most of the speakers) so much as to obtaining a simple, rational construction of bench and to secure a natural movement of the material throughout the gasification, believing that the inclined retort would hereafter serve only to represent and illustrate the transition period from the horizontal to the future vertical retort system. In the meantime the vertical retort has in fact been newly developed and has been introduced to technical gas practice in the shape of the "Dessau," the "Settle-Padfield" and the "Woodall-Duckham" oven systems.

The well-tried vertical retort, together with the to be looked for coming further development of the same, not only give promise to fully confirm the opinion formerly expressed, but to open up a new way for valuable progress in the future. By it we shall not only attain to a nicer, more rational oven construction and natural working conditions than we now have in the horizontal or inclined retort; besides, we shall have a better and larger yield of gas and ammonia; better coke and tar; gas practically free from naphthaline; greatly reduced labor requirements; and finally, perhaps, by means of continuous gasification with the addition of some water gas and withdrawal of the coke in a quenched and cool condition, also an extraordinarily desirable elimination of fumes as now involved in the course of gas manufacture. These advantages of the vertical retort system partly assured, in part still future, possibilities, are so exceedingly attractive, so greatly worthy of attainment, that it is really a requisite duty on our part to give the subject thorough attention, and to aid its introduction and further development with all our means and powers. Publications relating to vertical retorts came almost without exception (until now) from parties at interest. And, while no animadverse reflections may be ascribed with justice to the authors, it was only natural to brightly illuminate the advantages of one's own oven, and treat the other designs with less enthusiasm, or perhaps not mention them at all.

On the other hand, opponents would belittle sometimes brilliant results, combating the very idea that there was even a shadow of success inherent to the new design which was not their own. But this great and highly important subject deserves general, neutral and impartial investigation and criticism. With the intention to furnish a modest contribution in furtherance of the good cause, I would, so far as my means and limited time admit, illustrate and bring before you the existing, as well as the proposed designs for, construction of vertical retort oven systems, and to explain their characteristics as well as I can, of those which have come to my knowledge up to this present date—Jan. 1st, 1907. Let us review, as the first, the Dessau vertical retort, shown in Fig. 1. After quietly experimenting extensively with the vertical retort with side take-off, the details of construction of which were shown at the Darmstadt meeting, which style was afterwards abandoned, the German Continental Gas Company, of Dessau, caused the erection, under the special supervision of Dr. Bueb, of 2 benches, each with 10 vertical retorts, 13 feet 1 inch long, or high, and commenced operating them May 5th, 1905. When, after a lengthy period of continuous and satisfactory action, during which time they were constantly under most careful and exacting observation, their actual usefulness had been thoroughly demonstrated, this system of vertical retorts could be fairly regarded as reliable and practical in operation. In fact, as a new creation they could be submitted to the inspection and criticism of the gas world. On September 20th, 1905, occurred that remarkable event. The German Continental Gas Company had invited on that day both home and foreign gas men to Dessau to view their vertical retort benches, exhibiting them in full operation. This was the beginning of a new epoch in the manufacture of gas. A "finished whole" was presented to the gas public, the result of assiduous, industrious labor and devoted perseverance. The advantages of the vertical in comparison with horizontal or inclined retorts were plainly obvious.

You all are probably acquainted with the subject by reason of the earlier publications relating to this system. (See AMERICAN GAS LIGHT

1. *Jour. fur Gasbeleuchtung.*

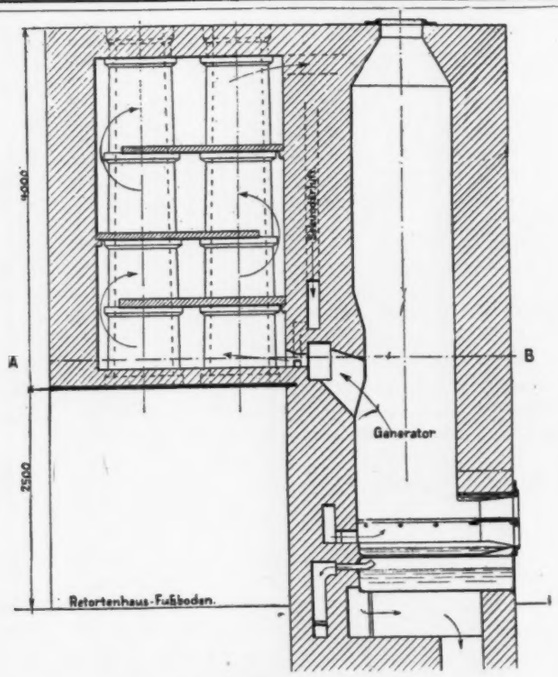


Fig. 1.—Dessauer Ofen.

JOURNAL, Vol. LXXXIV., pp. 267, 354, 442; and Vol. LXXXV., p. 55), and further references may be dispensed with at this time.

The construction of the bench is simple and natural, and the only things which did not appear to me quite faultless were the retort lid closing devices. Improvement on that point may be looked for, however, in future installations. The performance of these vertical retort benches after close watching and demonstration have been proved faultless, reliable and sure; and the results are conspicuously good. The yield of gas reached the maximum obtainable from the coal used, both as to quality and quantity and in illuminating as well as heating values; the coke is very hard, similar to the coke oven article; the tar is richer in hydrocarbons and thinner, and is no longer black but brown in color; and 50 per cent. more ammonia is produced than in the ordinary retorts. The gas is poor in naphthaline almost without it; and the work of serving the vertical retort benches is decidedly easier and greatly reduced besides. Two men only were required to attend the 2 benches, which uninterruptedly supplied the whole city of Dessau with gas for months. After the retorts are emptied they can easily be inspected, or patched should this be at all called for. About the same time a third trial bench was being operated at the Mariendorf works of the Imperial Continental Gas Association at Berlin; but in this instance the retorts, while also 10 to the bench, were 16 feet 4 inches in height, and like favorable results were obtained there. The realization of the patents and plans of construction was turned over to the "Deutschen Vertikalofen Gesellschaft" at Berlin, and there are now several cities in which vertical retort benches of the Dessau system are either in operation or in course of erection. The whole gas industry has abundant reason to subscribe with grateful recognition its indebtedness to the "Deutschen Kontinental Gas-Gesellschaft," for that Company's determined, lasting and leading efforts in this matter; and for the scientific thoroughness with which it caused all of these experiments with the vertical retorts, the new occurences in gasifying under entirely changed conditions, to be followed to their ultimates, and to be finally presented as a practical whole to the gas world.

The Dessau oven is an eminent step in the march of progress; but, shall we regard it as the final step in the evolution of the vertical retort? With its operation there is still combined the periodical filling and emptying, with the concomitant and unpleasant features such as smoke and vapor production during the charging and discharging stage; with its annoyance to the operatives, by heat and impure air, and danger from the rush of hot, falling coke. May not later on some continuous process of gasing bring with it the promise of also liberating us from these disadvantages?

(To be Continued.)

THE Columbia Company has taken over the properties of the Cincinnati, Newport and Covington Light and Traction Company.

A Kern Type of Inverted Incandescent Burner.

The *Journal des Usines a Gaz* notes that the Société Française de Chaleur et Lumiere, of Paris, is exploiting a type of the Kern inverted incandescent burner that has met with much favor. As shown in the illustrations, a corrugated device is carried on top which tends to keep the

Fig. 1.

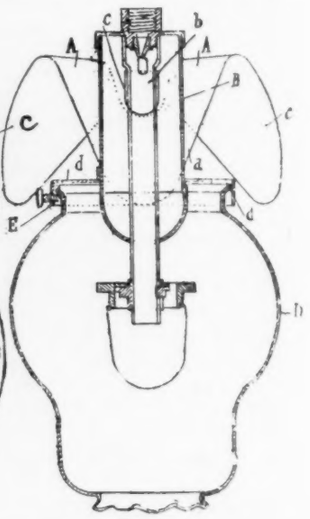


Fig. 2.

inlets for fresh air and the outlets for products of combustion apart from one another. The figures show the arrangement. At *a* the air is led up slopes to the openings *b*, and into the Bunsen burner through the tube *B*. The alternating corrugations *c* take the products of combustion out horizontally through the apertures *d*, and discharge them clear of the incoming stream of air supply. The Bunsen proper consists of a metal tube, preferably of a badly conducting metal such as iron or nickel, surrounded by a jacket which prevents the products of combustion from getting at the Bunsen tube and overheating it; and the space between the jacket and the Bunsen tube may be filled in with non-conducting material. This jacket has the effect of preventing striking back.

Lighting of Railway Premises, Indoor and Outdoor.

In a very exhaustive paper on this subject, read by Mr. Henry Fowler, of Derby, England, before the British Institution of Mechanical Engineers, the author had this to say about gas systems in connection therewith:

Oil Gas.—Lighting by this means is not, the author thinks, carried out on any railway station. It would require the provision of a set of retorts, and considerable storage if the retorts were not to be kept on continually. The cost would probably be slightly more than acetylene when all charges were taken into account.

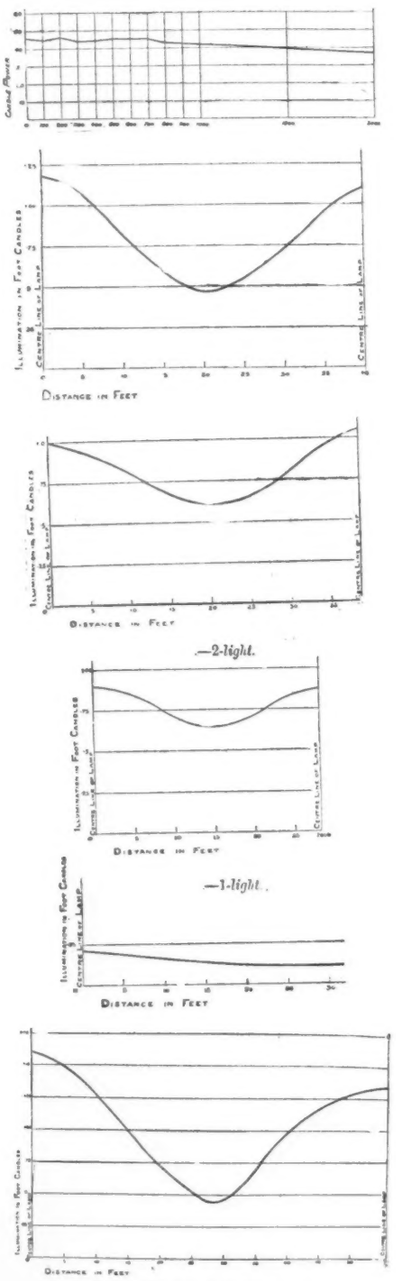
Gas Lighting: Flat Flame.—Until a little more than 10 years ago, except in a very few isolated cases, gas was the general illuminant for stations of any importance, and was almost universally used in an open or flat flame burner. It need scarcely be said that the lighting was not only poor, but, by present experience, costly for the results obtained. Although this type of burner is rapidly becoming out of date on all stations where many trains are run at night, yet it still supplies the greater part of the lighting on several of our British lines. On every company's system there are a number of stations on branches, etc., where the trains are not run late in the evening, and where artificial light is only required for a short period each evening, during a few of the winter months. In cases such as these the flat flame burner will probably continue to be used for some time, as the lighting required is not sufficient to make it worth while to employ incandescent burners, which, although much more efficient, require a certain amount for up-keep. It may be said that the difficulty might be overcome by only putting the incandescent burners on during these winter months, but it must be remembered that the lights must be available in cases of emergency at a moment's notice, and flat flame burners allow of this with a minimum of trouble and expense.

Incandescent Gas Lamps.—The greatest stride in gas lighting on railways and elsewhere was undoubtedly made when Auer von Welsbach devised his system of utilizing a Bunsen gas flame for heating to incandescence a mantle containing the rare earths thorium and cerium.

The author is not concerned in this paper with the reason for this incandescence, but only with the practical results it has given in his work. The construction, too, of the ordinary incandescent burner is too well known to need description. An ordinary C burner, using a gas giving 700 B. T. U. per cubic foot and consuming 3 cubic feet per hour, can be depended upon for giving a light on a photometer bar averaging 44.25 candles for 1,000 hours. A curve, Fig. 3, gives the average candle power of a number of mantles for 2,000 hours, as that is the length of time the author tests samples from various consignments. When the fixing solution of a mantle is burnt off, there only remain the ashes of the cotton stocking from which it was made and the rare earths, in solutions of which it has been dipped. It would at first sight seem that this was all too frail to stand the vibration which must exist on railway premises, but experience shows that this is not the case. On the Midland Railway there were in use on June 28, 1906, 48,392 of these burners, and although they are employed in all situations, the mantle consumption cannot be said to be high, as it only averaged 5.2 mantles per burner per annum. Under ordinary circumstances with pillar lamps, where a good foundation for the pillar has been secured, and in nearly all cases with suspended lamps, it has not been found necessary to provide any type of antivibrating apparatus to preserve the mantles. When, however, a good foundation cannot be secured, and the vibration is excessive, the use of a simple apparatus, consisting of a frame suspended by a spring on which the burner is fixed, and to which gas is supplied by a rubber connection at the bottom, has been found advantageous.

It will doubtless be noted that the author has so far only mentioned the ordinary C incandescent burner; he is perfectly aware that various Kern types of burners with their longer and better designed mixing chambers for the gas and air give a higher efficiency, but he has found that they require greater attention than those of the C type. On the photometer bar this type of burner (Kern) will give over 20 candles per cubic foot of gas burnt per hour, but for the reason stated he has not recommended their general use on the line. As will be readily understood, the number of burners inserted in a lamp and the distance of the lamps apart, is a matter to be considered in each particular case. Having a unit of light of about 50 candles (of which any multiple can be easily provided) allows of a very even lighting being obtained where necessary. As a rule not more than three burners are grouped together for station lighting, although groups of five are used in special cases. With small stations single burners, placed as with flat flame lamps, about 60 feet apart, give a good effect. Generally the lamps are spaced closer together under a station roof than in the open, for this latter is the portion of the station most in use. As a rule the distance between the lamps rarely exceeds 70 feet, and not often are they closer together than 40 feet, whilst the height of the mantle above the platform varies from 9 feet 6 inches to about 14 feet.

High Pressure Incandescent Gas.—Many attempts have been made to get a greater efficiency out of a cubic foot of gas than is given by an ordinary incandescent burner at pressures up to 2 inches of water. Some 4 or 5 years ago it was found that by using a much higher pressure than usual and allowing the air and gas to mix together in a longer chamber, better results were obtained. The pressure used was that of from 8 to 10 inches of water. The mantles are without chimney, and at a pressure of 10 inches of water give 240.68 candles with a consuption of 10.18 cubic feet of gas per hour. It would seem that the best efficiency is obtained with a burner of this size, and it is not always that so large a unit of light is required, but, when it is, the use of such burners is economical. Arrangements have to be made to raise the gas to the required pressure from 1 to 3 inches of water, which is the pressure of the usual supply. This is done by pumps which may be driven by water, a gas engine, or electric motor. In the earlier types of plant, water power was extensively used, but as the amount required varied from 188 to 327 gallons per 1,000 cubic feet of gas compressed, it will readily be understood that this method was found to be in some cases expensive. More recently small gas engines have been used for driving the compressing pumps, and in a plant, the carrying out of which the author has had charge of, the gas consumed by the gas engine has been only 20.8 cubic feet per 1,000 cubic feet of gas compressed. This plant, which will consist of over 300 burners when complete, is giving very good results, from a lighting and economical standpoint, with 2-burner lamps placed 56 feet apart and with mantles 13 feet above the platform. A curve of the illumination is given in Fig. 2, the line being 11 feet 6 inches from the line of the lamps The lighting effect is very good, and free from patchiness. As previously stated, it is not every station where the illumination required necessitates the use of as large units of light. The mantle consumption of burners of this type is higher than with ordinary ones, and may under railway conditions be taken as 8-10 mantles per annum.



Figs. 1 to 6.

5-light lamps,	41	feet	apart,	readings	1.18	maximum	to	0.45	minimum.
3-	"	"	38	"	"	"	1.1	"	"	0.6	"
2-	"	"	28	"	"	"	0.9	"	"	0.65	"
1-	"	"	58	"	"	"	0.23	"	"	0.10	"

	Height of Lamps. Feet.	Inches.		Feet	Inches.	
5-light curve	10	10.	Curve taken	6	0	from line of lamps.
3- " "	10	4½.	" "	6	3	" "
2- " "	9	8.	" "	5	9	" "
1- " "	9	9.	" "	6	0	" "

More recently several systems of lighting have been devised in which the pressure at which the gas is burnt is very much higher, rising in some cases to 54 inches of water. The result is that a still greater efficiency per cubic foot is obtained, but the unit of light is raised higher than is usually required for railway purposes. One railway company employs one of these systems for dock lighting, whilst one of the best pieces of street lighting, the author has seen, that of Alexander Platz, Berlin, is with this type of burner.

Self-Intensified Burners.—The provision of high pressure gas necessitates the laying of special mains, or at all events of having gas of a higher pressure in the mains than is usually the case. This has led to

the invention of several types of lamps which are arranged to give the same effect independently, either by induced draught or by the provision of some mechanism in the head of the lamp for raising the pressure of the air supply to the burner to about 30 inches of water. Some of these types seem to work admirably, but the author has not had sufficient success with them to cause him to recommend their adoption extensively, but this may be due to local conditions. At all events, the results aimed at are those given in the figures mentioned with high pressure lighting.

Interior Lighting.—Interior lighting on a station in the majority of places is confined to small rooms, with the result that the light is usually required at some particular point, and consequently it is placed as near this point as possible. About the largest interior spaces requiring attention are parcel offices, and in these it is found that an illumination varying from 0.9 of a foot-candle on the floor gives good results. This can be obtained by 3-light suspended C gas burners placed under an enameled reflector.

Within the last year or two the inverted type of burner has been much improved, and the smaller types supply a want in gas lighting, as they give an economical light of about 12 candles.

This type of burner lends itself to much more artistic treatment with its fittings than any other type, but this is not a point which gets much consideration in lighting a railway, except perhaps in refreshment rooms.

February Meeting, New York Section Illuminating Engineering Society.

At the February meeting of the New York Section of the Illuminating Engineering Society, the section officers elected for the ensuing year were: Mr. Albert E. Forstall, Chairman; Messrs. Manning K. Eyre and T. R. Beal, Managers; and Mr. Preston S. Millar, Secretary. The paper of the evening was one on the "Photometry of Incandescent Gas Lamps," presented by Mr. Thomas J. Little, Jr., of the Welsbach Company, dealing with photometry from a practical standpoint, and avoiding all theoretical discussion of instruments and devices.

A complete description was given of the equipment required in the photometer room and many suggestions were made concerning the precautions which must be taken to insure accurate measurements. The author stated that satisfactory results had been obtained from the pentane lamp of the Harcourt type as a standard of illumination; it is simple and transportable. Pentane of proper specific gravity may now be obtained readily, and the pentane lamp in its present form is perfectly safe. If a complete equipment of testing instruments, storage batteries, master standards, standards and sub-standards are available, the incandescent electric lamp is well suited as a standard of illumination.

The author of the paper expressed his preference for a modified form of the Dibdin radial photometer. With this photometer the lamp the light of which is to be measured is suspended from the horizontal bar which slides between a pair of uprights. A radius rod is connected to the sight-box, which is mounted upon a table, the latter traveling on a track along the floor. The standard is mounted on a carriage which may be moved along the track on the table. Radial readings can be made through 180° in a vertical plane, and, by shifting the burner, 180° in the horizontal plane. Many suggestions were made as to the best methods to employ in calipering a mantle in order to determine the amount of shrinkage during its life. The importance of using throughout the test a uniform quality of gas at a constant pressure was discussed at great length and illustrated by means of curves showing the results of actual tests.

The discussion was opened by Mr. W. C. Morris, who said that the numerous precautions mentioned by the author are absolutely essential if reliable results are to be obtained. He stated that discrepancies in results from tests made under what seemed to be exactly similar conditions were found to be attributable to the change in temperature of the air surrounding the pipe through which the gas was led to the lamp. Although the error in reading the setting of the photometer may be decreased by using a long photometer bar, there are conditions under which it is advantageous to employ a short bar. Thus when the lamps under test are of small illuminating values it is desirable that the distance between the lamp under test and the standard be not too great. The lamp should in all cases be screened from both the disk and the eyes of the observer. The observer should make readings on both sides of the bar in order to eliminate any error due to unsymmetrical vision.

Mr. V. R. Lansingh called attention to the fact that all of the equipment described by the author, and the walls of the room in which the photometer apparatus was placed, were painted black. He remarked that the precaution in this respect would be unnecessary if the proper number of screens were used. At the Bureau of Standards the photometer rooms are equipped with white walls, and the rooms are very much more cheerful than those in which black walls are used.

Mr. Victor A. Rettich spoke of the advantages to be derived from standardizing both the mantle and burner of an incandescent gas lamp. If standard burners are used, new forms of mantles can easily be compared with standard mantles. Likewise when standard burners are employed, special forms of mantles can readily be compared with standard mantles. He called attention to the fact that it is preferable to remove the collodion from the mantle by igniting from the bottom rather than from the top, in order that the ascending flame may thoroughly consume such gases as might otherwise produce a disagreeable odor.

Dr. Clayton H. Sharp spoke of the distribution of illumination around the incandescent gas lamp, and expressed the opinion that it is preferable to ascertain the intensity in all directions rather than in only one. The importance of such method of measurement will be appreciated when the inverted mantle lamp is compared with the more usual form of lamp. Although white walls can be used in the photometer room, provided the proper number of screens are placed along the photometer bar, more satisfactory results are obtained when the walls are black.

Mr. Preston S. Millar stated that the amount of fatigue of the eyes of the observer is much less when the walls are painted black instead of white.

In closing the discussion, Mr. Little remarked that the intensity of illumination in the horizontal plane is much more uniform with an incandescent gas lamp than with an incandescent electric lamp. Although observations of the intensity of illumination from one part of the burner does not furnish accurate information concerning the intensity at other parts, yet the difference is not very great and in a life test of a mantle it is preferable to make a series of observations of the illumination from a single section of the mantle. The real object in using screens along the photometer bar is to prevent the light from the lamps reaching the eyes directly, because it is difficult for the pupil of the eye to become adjusted rapidly to a considerable change in the intensity of illumination.

It was announced that the March meeting of the Illuminating Engineering Society will take the form of a symposium, at which the illumination of large interiors will be discussed.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

"J. M. B.," writing from the Pacific Coast under date of the 9th inst., says: "Dear JOURNAL: Conditions relative to the gas situation in Los Angeles have become very interesting, where a new company has just been formed by a syndicate of local bankers, with a capitalization of $10,000,000. They propose to immediately begin the installation of an up-to-date plant having an initial *per diem* capacity of 5,000,000 cubic feet. The Edison Electric Company has contracted with the Stacey Manufacturing Company for a 100,000 cubic foot capacity holder for the gas plant at Riverside, Cal.; a 75,000 holder for Santa Ana, Cal., and a 50,000 holder for Monrovia, Cal. The plant completed by the Edison Electric Company for Long Beach, Cal., last September, has already exceeded the calculations of its designers as to future capacity, and plans are now being drawn for a new generating set up to a daily output of 1,000,000 cubic feet. The planning also includes an exhaustor and purifier outfit and a 500,000-foot storage holder in 2 lifts.

"W. C.," writing from Buffalo, N. Y., under date of the 15th inst., informs us that the executive officers chosen by the Natural Gas Company of that city are: President, C. N. Payne—succeeding the late Daniel O'Day; Vice-President, John Bushnell; Secretary and Treasurer, John McManus; General Manager, W. W. Richardson; Assistant Secretary, L. B. Doyer: Assistant Treasurer, W. M. Cussack; Superintendent, John McManus; Assistant Superintendent, J. H. Walsh.

MR. GLENN R. CHAMBERLAIN, to whose cleverness as a business man the Grand Rapids (Mich.) Gas Light Company owes much, in speaking some days ago about the demand for coke in the named city, remarked: "There has been a coke famine in Grand Rapids for some time. The shortage commenced early last January when the reserve stock was exhausted, and since then the city has been dependent upon our daily output, which will average about 100 tons. Of this we retain half for our own customers, the other half being distributed to the local dealers in proportion based on their sales last year. As the demand greatly exceeds this small supply many used to burning coke are greatly inconvenienced and considerable delay is found in filling orders. We have a number of contracts to furnish coke on demand during the winter and to protect these customers we have stopped burning coke at the works and are using coal in our furnaces. The coal shortage of last month has been relieved entirely, the car shortage being responsible for that, but during the shortage we were compelled to draw heavily on

our coke for our own use and the reserves ran short. However, there will be no advance in the price on that account."

THERE is a dispenser of celestial light in Wilkes-Barre, Pa., whose name is the Rev. H. R. Hughes, and he is Pastor of the Welsh Congregational of that compoundly named place. One evening not long ago when Divine Providence was bestowing zero weather upon the Reverend Hughes and his flock, and the Gas Company was sharing in the frigid deal, the pastor had this to say by way of prelude to a meeting which he was about to conduct: "From an earthly standpoint this service is dark, but let us hope that from a spiritual view it will be illuminated. I hope the spiritual light will guide through the service, for I am convinced that we can expect little from the hands of the Gas Company." Meanwhile the service gangs of the Company were on the jump, etherealizing the risers of many meters, chiefly by means of frequent applications of wood alcohol there through. But the Reverend Hughes thought not of this; his troubles were paramount. He was the man.

UNDER the agreement whereby the Union Gas and Electric Company, of Cincinnati, O., is to supply gas to the residents of the outlying suburb of College Hill, it is specified that the charge for a service on lighting account is not to exceed 75 cents per 1,000, net, or 85 cents per 1,000, gross. The charge for artificial gas supplied on fuel account (through separate meter) is 50 cents per 1,000, net, or 60 cents per 1,000, gross.

MR. ROGERS, of Danbury, Conn , has introduced a bill in the State Legislature, under which it is proposed to establish a Commission of Gas and Electricity. The same is to comprise 3 members, to be nominated by the Governor and confirmed by the Senate. It is to have power to exercise general supervision over all persons or corporations supplying gas or electric currents for light, heat or power purposes, as to prices, quality and the like. The main office of the Commission shall be in Hartford, and a branch thereof is to be maintained in New Haven.

THE report of the officers in charge of the municipally operated gas system of Belleville, Canada, goes to show that the expenditures in connection therewith during 1906 amounted to $21,041.39, and that the receipts amounted to $20,406.73. The balance, however, did show uncollected accounts amounting to $6,401.11.

AT the annual meeting of the Ottawa, Canada, Gas Company, the annual reports showed a very satisfactory increase in business over that of the preceding year. Over 5 miles were added to the Company's main system, and extensive additions to it the present year had been planned. No change was made in the executive management.

AT the annual meeting of the Cairo City (Ills.) Gas Company, the only change in the executive management was the election of Mr. John Halliday to the Board of Directors, vice Mr. John W. Eakin. The latter was succeeded as Secretary by Mr. John Tiernan.

MR. CHARLES S. HARWOOD, for some time identified with the electric division of the business of the Denver (Col.) Gas and Electric Light Company, died at his home in Denver, Monday, the 4th inst. He was in his 26th year.

A GOODLY audience paid close attention to a lecture on the "Proper Use of Artificial Light," which was given in Pueblo, Col., by Mr. Albert J. Marshall, at the invitation of the Pueblo Gas and Fuel Company, some evenings ago.

THE Consumers Gas Company, of Reading, Pa., is comfortably installed in its well equipped office quarters, in a well located, handsome business structure on Court street, below Fifth.

IT was merely for the principle of the contention, with a view to the establishing of a precedent as well, that the Citizens Gas and Electric Company, of Waterloo, Ia., prosecuted this suit to a successful termination. The Company sued the Canfield Lumber Comany, of Waterloo, for 25 cents, which claim rested on these premises. The Company allows a rebate of 10 per cent. on all bills paid on or before the 10th day of the month in which they are presented, otherwise the gross rate prevails. On Janaary 2d, the Canfield Company received a bill for gas consumed the previous month, amounting to $2.50. On the 11th the Company forwarded a check to the Gas and Electric Company for $2.25, taking off the discount, a day after the fair, as it were. An argument ensued and the suit resulted, with a decision in favor of the Gas and Electric Company. By-the-way, the costs amounted to $20.

THE Denver (Col.) Gas and Electric Company has, through its commercial department, just issued a handsome brochure, well showing what gas can be used for in many directions.

UNDER the tentative agreement—there is little doubt that it will shortly become a working agreement—between the authorities of Watertown, N. Y., and the Watertown Gas Light and the Watertown Electric Light Companies, the rates for a supply of gas and electric currents will rule at these figures: Gross, for gas, per 1,000 cubic feet, $1.35; net, $1.25; for electricity, gross, per 1,000 watts, 12 cents; net, 10 cents.

THE plant and properties of the Wooster (O.) Gas Light Company, which were sold recently at receiver's sale, were purchased by M. J. Kauke, of Pittsburgh, Pa., at his bid of $4,000. The plant will be remodeled.

THE name of the Belleville (Ills.) Gas and Electric Company has been changed to that of the St. Clair County Gas and Electric Company, and its capital has been increased from $350,000 to $3,500,000.

THE Peoples Gas Light and Coke Company, of Chicago, Ills,, has given notice that all of the property of the Universal Gas Company, of Chicago, is now operated by it under the terms of the State legislative act that became effective July 1st, 1897.

THE City Attorney of Dallas, Tex., has been instructed to prepare an ordinance directing that, on and after a date to be determined, no "Gas Company doing business in the city of Dallas" shall charge consumers for artificial gas furnished at $1.10 per 1,000 cubic feet, with a discount of 10 cents per 1,000 when the bills are paid within 10 days.

ACCORDING to a correspondent an increase in sales by its operating companies, amounting to 25 per cent. in the gas and 9 per cent. in the electric departments, respectively, of the Massachusetts Lighting Companies, is shown in the annual reports submitted by the President, Mr. Arthur E. Child. During the year two concessions in prices were made, but in each case the increase in business more than offset the lessened rate. During the year 1905 additional shares of stock were issued, and the proceeds thereof were employed to purchase the capital stock of the Leominster Gas Light Company and of the Worcester County Gas Company. Over 90 per cent. of the stock of the Light, Heat and Power Corporation has been purchased, which acquiring gives the former complete direction of the Construction Company. For the year ended December 31, 1906, the gross receipts from the sales of gas, etc., were $134,443, and from electricity, $129,341.

MR. AMBROSE PETREY and associates, of Detroit, Mich., have purchased the properties of the New Castle (Ind.) Light, Heat and Power Company, which concern has heretofore controlled the electrical and natural gas properties of that city. The syndicate proposes, owing to the failing supply of natural gas, to construct a works up to the needs of New Castle in such respects on manufactured account.

THE following interesting items are culled from the report of President Knapp to the shareholders of the Peoples Gas Light and Coke Company respecting the operations of the Company for the twelvemonth ended December 31st, 1906: "Since the last stockholders' meeting the City Council of Chicago fixed the net rate to be charged by gas companies at 85 cents per 1,000 cubic feet, the rate by agreement with the Company, being made operative from February 1st last, and the rate thus fixed is to continue without change until February, 1911. During the year the matter of securing an increased supply of natural gas was taken up. It will be remembered that in November, 1905, owing to the inability of this Company to secure an adequate supply of natural gas, it became necessary to discontinue furnishing natural gas to all consumers thereof north of the Chicago river. After much negotiation an agreement was finally reached whereby this Company not only secures an increased supply of natural gas but also substantial benefits in respect to its future oil supply, and natural gas is again being furnished to the territory that was abandoned in November, 1905. The agreement made involved this Company's guaranteeing the outstanding capital, bonds and stock at par of the Indiana Natural Gas and Oil Company, aggregating $6,000,000, but the investigation made by the Board prior to consummating the agreement indicated that the earnings from natural gas and other advantages accruing under the agreement will provide for the obligations assumed by the Company under the guaranty. During the process of the hearing and investigation by the City Council, which preceded the fixing of rates to be charged, this Board, on Dec. 19, 1906, felt impelled as a matter of prudence to reduce the dividend rate from 6 per cent., theretofore paid, to 5 per cent. The last named rate was paid during the year 1906, but the Board at its last meeting, January 25, 1907, restored the dividend rate to 6 per cent., believing the earnings justified it, and impressed with the conviction that the minimum rate to which the stockholders are entitled is 6 per cent. per annum. The Board has no hesitation in expressing its confidence that, under normal conditions, the earnings will justify the continuance of this rate."

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NOTIFICATION RESPECTING ADVERTISING.

Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Co., 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, FEBRUARY 25, 1907.

The Market for Gas Securities.

The recent rise in Consolidated gas has been fairly well maintained, and the net result in the trading is that many inquiries are being made for the stock by those shrewd people known as sure-thing investors, who are not in any sense speculators. A fair share of the inquiring, too, came from abroad, the writer knowing himself of a block of 200 shares purchased for account of a resident of Berlin, Germany. Brooklyn Union is in some demand, and that there is going to be a better demand for it, and that forthwith, is reasonably certain.

Peoples, of Chicago, more than holds its own, and Massachusetts gas does likewise. We repeat again our advice as to the purchase of these shares. One cannot make a mistake in buying them. Lacledes are steady, as good interest payers should be. On the whole, the market outlook regarding gas shares has not been more favorable in years.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

FEBRUARY 25.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	137	138
Central Union Gas Co.—				
1st 5's, due 1972, J. & J	3,000,000	1,000	101	104
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	..	105
Mutual	3,500,000	100	190	225
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000 000	1,000	98½	100
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p.ct.	1,000,000	..	96	104
Northern Union—				
1st 5's, due 1927, J. & J	1,250,000	1,000	101	103
New York and East River—				
1st 5's, due 1944, J. & J	2,500,000	1,000	108	111
Con. 5's, due 1945, J. & J.	1,500,000	..	104	110
Standard	5,000,000	100	140	160
Preferred	5,000,000	100	155	175
1st Mtg. 5's, due 1930, M. & N	1,500,000	1,000	104	108
The Brooklyn Union	15,000,000	1,000	112	122
1st Con. 5's, due 1948, M. & N	15,000,000		107	..
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Bay State	50,000,000	50	¼	⅜
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	..	65
" 1st Mtg. 5's	509,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	9	10
" " Bonds, 5's	5,250,000	1,000	75	80
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	106¾
Cincinnati Gas and Electric Co.	29,500,000	100	100	100½
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	90	..
Columbus (O.) Gas Lt. & Heating Co	1,683,750	100	..	95
Preferred	3,026,500	100	107½	108
Consumers, Toronto	2,300,000	50	200	204
Consolidated, Baltimore	11,000,000	100	.	90
Mortgage, 6's	3,600,000	..	..	118
Cheapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	..	..	100
Detroit City Gas Co	5,000,000	50	..	50
" Prior Lien 5's	4,618,000	1,000	..	98
Detroit Gas Co., 5's	381,000	1,000	75	80
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	39	40
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	..	110	112
Bonds, 5's	10,500,000	..	107½	108½
Indianapolis	2,000,000	..	60	70
" Bonds, 5's	2,650,000	..	104½	105
Jackson Gas Co	250,000	50	82	..
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	..	05
Preferred	2,500,000	100	95	110
Bonds	10,000,000	1,000	104	104¼
Lafayette Gas Co., Ind	1,000,000	100	..	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	106	108¾
" 6 per cent. scrip, due 1910	100,000	25	85	87
Massachusetts Gas Companies of Boston	25,000,000	100	65¼	66
Preferred	25,000,000	100	85	85½
Montreal, Canada	2,000,000	100	218	218¾
Nashville Gas Lt. Co.	1,000,000	100	110	..
Newark, N. J., Con. Gas Co.	6,000,000	..	56	58
Bonds, 6's	6,000,000	..	137	138
New Haven	2,000,000	25	200	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	93½	93¾
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
" 2d "	2,500,000	1,000	104	..
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	104¼	105¼
San Francisco, Cal.	15,800,000	100	..	..
St. Joseph Gas Co. 1st Mtg. 5's	751,000	1,000	92	..
St. Paul Gas Light Co	1,500.000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465.000	1,000	96¼	..
Syracuse, N. Y.	1,975,000	100	50	55
Bonds	2,047.000	1,000	102	..
Washington, D. C	2,600,000	20	281⅞	285
First mortgage 6's	600,000	..	..	..
Western. Milwaukee	4,000,000	..	..	..
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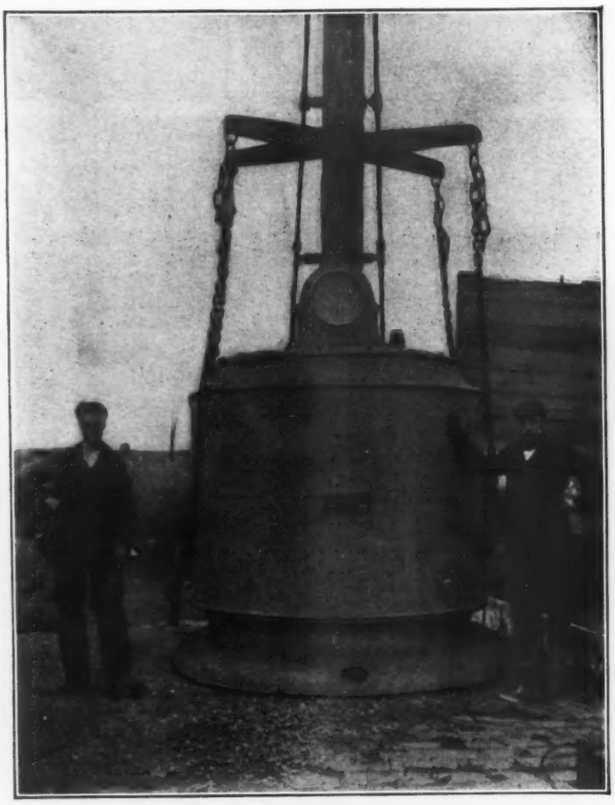

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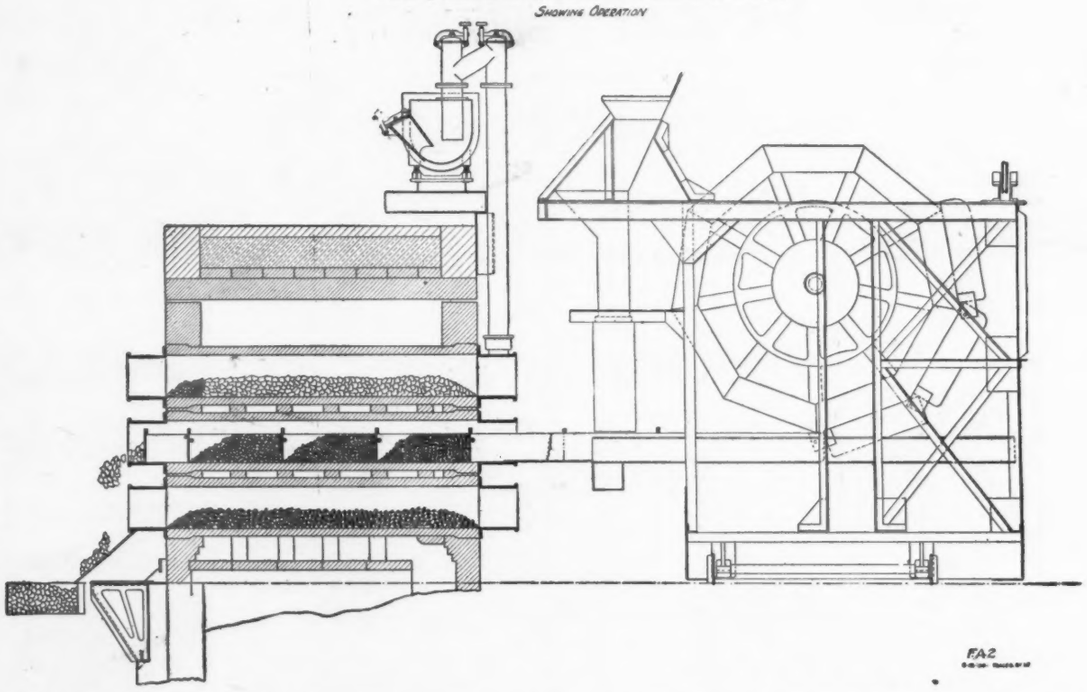

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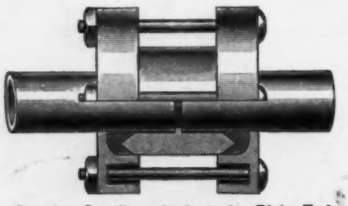
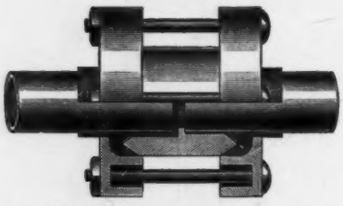
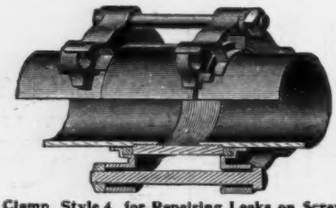
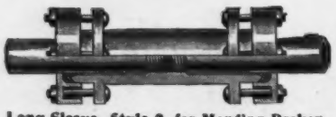

Regular Coupling, Style 1, for Plain End Wrought Iron Pipe.


Insulating Coupling, Style 5, for Plain End Wrought Iron Pipe,


Clamp, Style 4, for Repairing Leaks on Screw Collar.


Long Sleeve, Style 2, for Mending Broken Lines.

S. R. DRESSER MANUFACTURING CO.,

SUCCESSORS TO

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BRADFORD, PA., U. S. A.,

Patentee and Manufacturer of Specialties for Gas and Water Lines,

Pipe Couplings, Sleeves, Clamps, Crosses, Tees and Ells.

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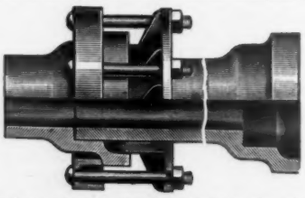
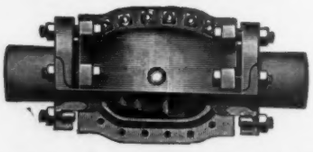
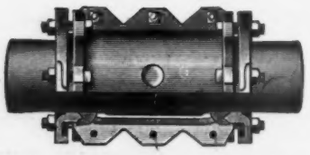
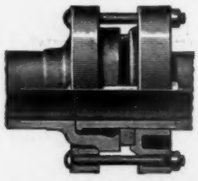

Coupling, Style 9, for Special Style Cast Iron Pipe.


Split Sleeve for Repairing Broken Bell on Cast Iron Pipe.


Split Sleeve for Repairing Broken or Cracked Cast Iron Pipe.


Clamp, Style 4½, for Repairing Leaky Lead or Cement Joints in Cast Iron Pipe.

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We know wherein every one of the twenty-odd imitations differ from the "Ramsdell" Inverted Gas Lamp—the "Rico" brand.

The difference in one or two cases is only slight, but it is just that difference that makes the "Ramsdell" Lamp a practically perfect and highly satisfactory lamp.

That same little difference is what will keep the "Ramsdell" Lamp popular long after the imitators are all forgotten.

It is to the interest of the gas manufacturer to have every customer understand this difference at the start.

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RICO RICO RICO RICO RICO

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(Incorporated),

GAS ENGINEERS,

DESIGN, CONSTRUCT AND OPERATE COMPLETE COAL, WATER AND CRUDE OIL GAS PLANTS.

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AMERICAN TRUST BUILDING,

CHICAGO.

MUELLER PIPE END REAMERS.

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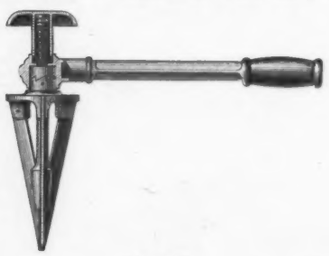

C-035.

Ream all sizes of pipe up to 3-inch. Complete with handle. Do away with brace or stock, lighten the kit and save time in getting ready. Plain or ratchet handle.

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FOR THE

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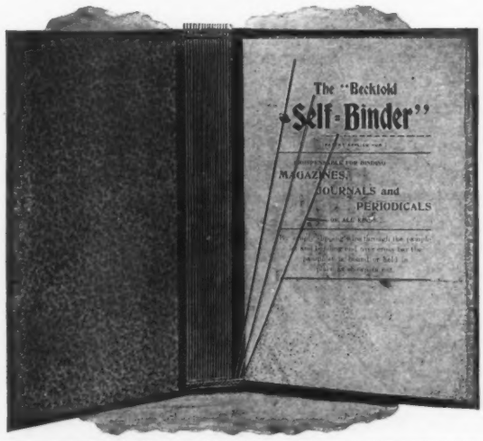

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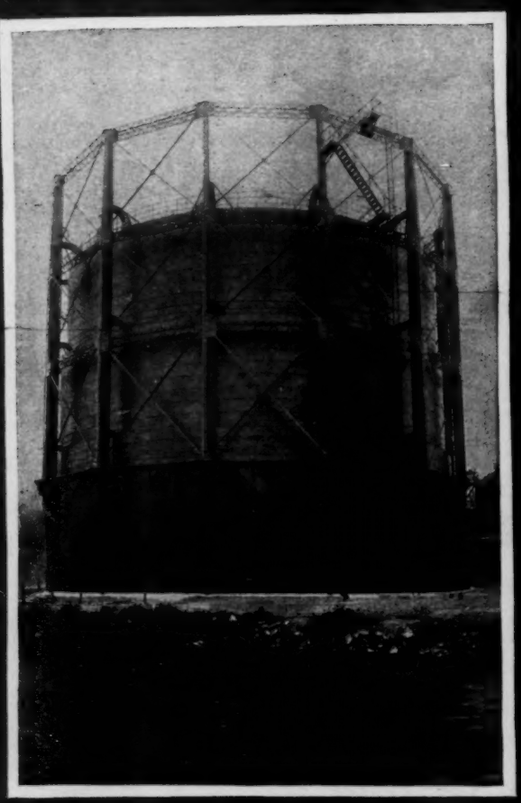
FOR SALE BY

A. M. CALLENDER & CO., - 42 Pine St., New York.



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Purifier Covers
General Plate Metal Work and
Steel Water Towers

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PRIMARY AND SECONDARY CONDENSERS FOR FRESH OR SALT WATER

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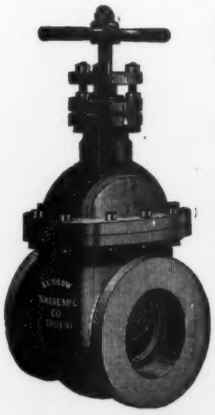

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Double and Single Gate Valves, ¼" to 72",

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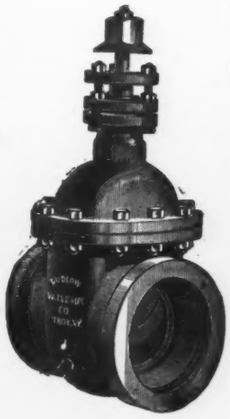

This cut shows the Hunt Cable Car handling coke (cold) which has been quenched in the Mann chute.

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FOUNDED 1872.

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Also "Industrial," Automatic and Cable Railways, including cars for unusual conditions.

Bristol's Recording Pressure Gauges

—(ALL RANGES).—

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For Every Gas Plant.

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For Gas, Water and Electric Light Companies, at No. 41 Wall Street, Room 1707, New York.

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Modern Machine Shop Construction, Equipment and Management,

By OSCAR E. PERRIGO, M.E.

Price, $5. For Sale by

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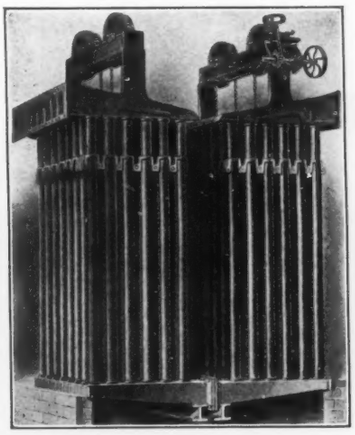


HOW MUCH COAL PER 1,000 CU. FT. OF WATER GAS?

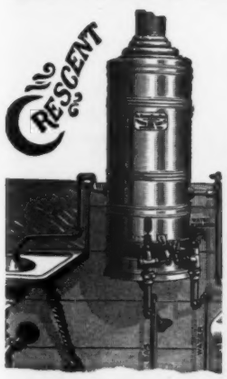
If the process of making water gas were theoretically perfect, only 24 lbs. of coal would be consumed per 1,000 cu. ft. of gas generated. As a matter of fact, the actual figures are between 40 and 48 lbs. per 1,000 cu. ft. It is apparent that there is a waste somewhere, and if you will take the trouble to put a thermometer over the stack valve during the "blowing up" period, you will see where the heat goes to. From one-third to one-half of the heat escapes to the atmosphere, either as sensible heat or latent heat of combustion. If use can be found for this heat a great economy could be effected immediately.

We have found such a use. By means of the Green Air Heater 12 per cent. to 15 per cent. of this heat, or more, can be imparted to the air blown to the generator. This will reduce the time for blowing up and increase the temperature of the generator, so that about the same proportion of coal will be saved.

After the gases have passed through the air heater they are still hot enough to use in a Green Fuel Economizer to heat the boiler-feed water up to the evaporative point. In In this way a quarter of the boiler coal can be saved. In connection with a 6-ft. generator an investment of $3,500 in an Air Heater and an Economizer will save from $2,300 to $2,500 per year. This ought to repay you for the trouble of writing us for further information. Ask for Circular "A G."

THE GREEN FUEL ECONOMIZER CO.,
MATTEAWAN, N. Y.

(Sole builders of the Green Fuel Economizer in this country; we also build Fans and Blowers.)



FOR HOT BATHS,

And for every other Hot Water Need, use the

IMPROVED

HUMPHREY CRESCENT INSTANTANEOUS WATER HEATERS.

Efficient. Compact. Durable. Every Heater Guaranteed.

No. Heaters.	Price.	Gas Supply from Meter.	Heats Gals. per Min. 50° in Temperature.	Height.	Diameter.	Shipping Weight.
Non-Contact.. 2	$40.00	¾ Inch.	2½	34⅝ Inches.	12 Inches.	70 Pounds.
Contact..... 6	29.00	¾ "	3	29 "	12 "	60 "
" 8	23.50	1 "	2½	23½ "	10¼ "	48 "

These prices include Safety Valves and Unions, one Bent Output Spout. For prices of fittings see our complete catalogue, "The Luxury of a Bath."

We will be glad to quote Discounts.

HUMPHREY CO., · · · Kalamazoo, Mich.

The ONLY manufacturers in the world of a complete line of Instantaneous Water Heaters.

LLOYD'S SUBMERSION WASHERS.

Maximum Efficiency,
Minimum Back Pressure,
Complete Safety.

Western Sales Agent
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LLOYD CONSTRUCTION CO., Detroit, Mich.

WHY DO GAS EXHAUSTERS

AND HIGH PRESSURE GAS PUMPS BUILT BY

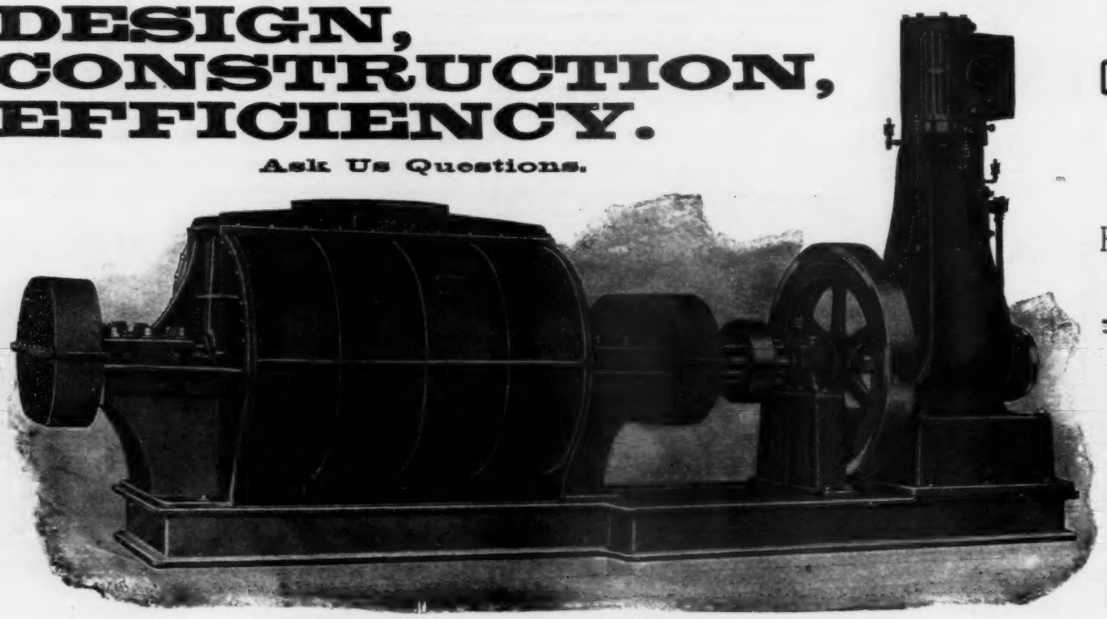
THE CONNERSVILLE BLOWER CO.

Stand so High in the estimation of those using them?

THE ANSWER IS IN THREE WORDS:

DESIGN, CONSTRUCTION, EFFICIENCY.

Ask Us Questions.



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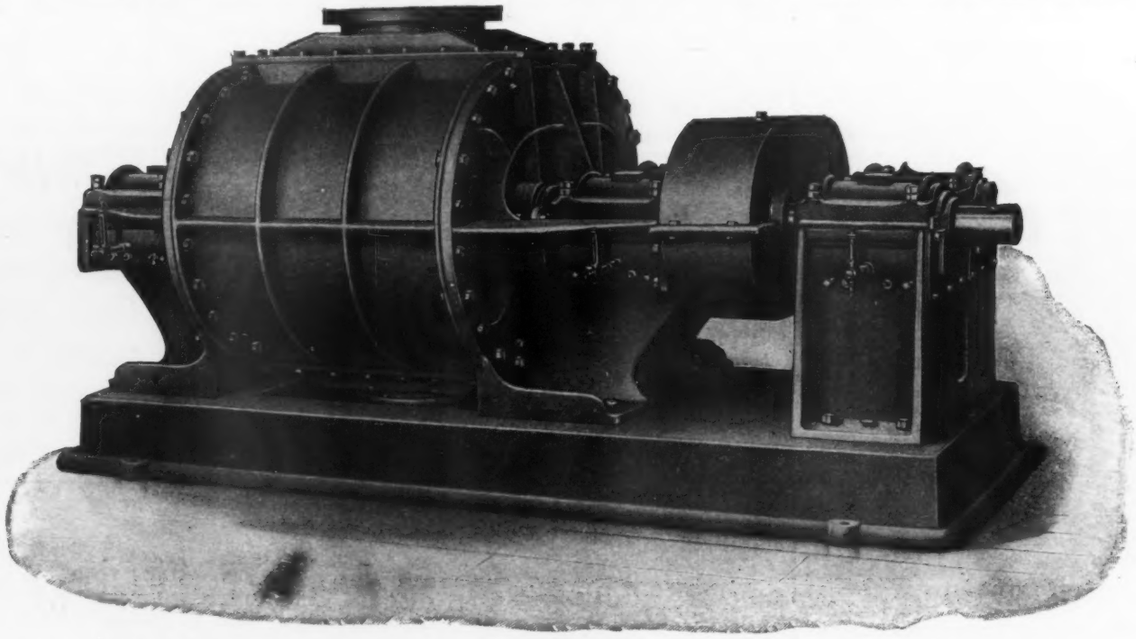
ROOTS' EXHAUSTERS for HIGH and LOW PRESSURE WORK.

The highest efficiencies obtained. Most perfect devices for adjustment and maintenance of proper alignment. Use our flexible coupling to correct troubles caused by misalignment and engine shaft thrust. Our gas governor is the best. By-pass, gas valves and fittings.



P. H. & F. M. ROOTS COMPANY,

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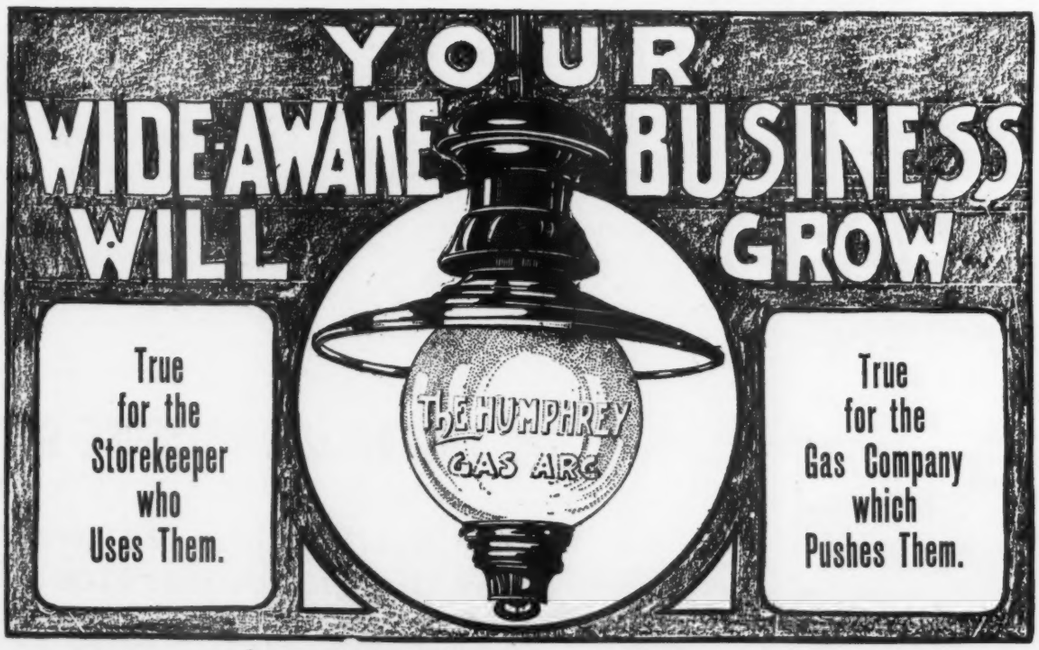

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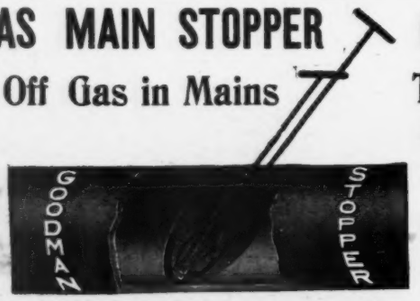
For Shutting Off Gas in Mains

Any size gas main can be shut off in 30 seconds. : : :



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Chollar's System of Gas Purification.

THE PURIFIED GAS REVIVES THE FOULED OXIDE.

Practical Handbook on

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Price, $1. For Sale by

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Do You Wish to Know

what size of pipe to use to convey any quantity of gas, any distance, with any loss of pressure and any initial or final pressure? Then use

Cox's Gas Flow Computer,

as it gives this information accurately at sight, without mental effort. No calculations needed. Saves time, money and mistakes.

Price, 6.5 x 8 inches, in cloth case, $2.50.
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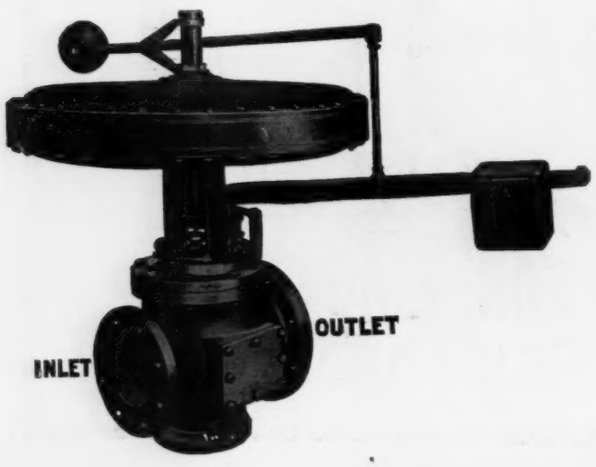

THE FULTON GAS PRESSURE GOVERNOR,

WITH AUTOMATIC SAFETY CUTOFF.

For Artificial or Natural Gas.
For District or Service Use.

Our DUPLEX SENSITIVE GOVERNOR, with Automatic Cutoff for district service, will reduce high pressure gas to inches of water without variation.

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Photometrical and Experimental Apparatus.

PUBLIC LIGHTING TABLE.

MARCH, 1907.

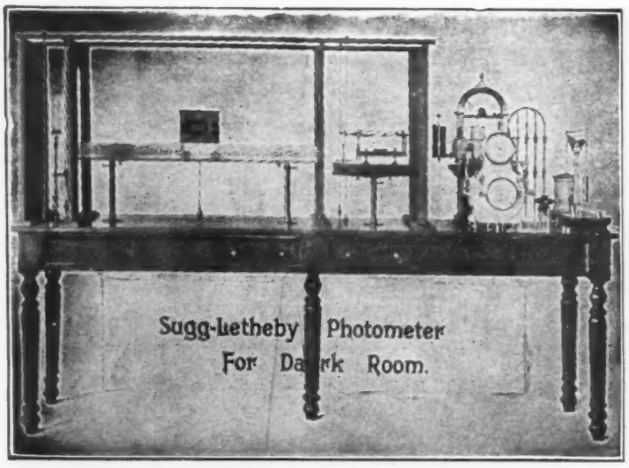
Table No. 1.
FOLLOWING THE MOON.

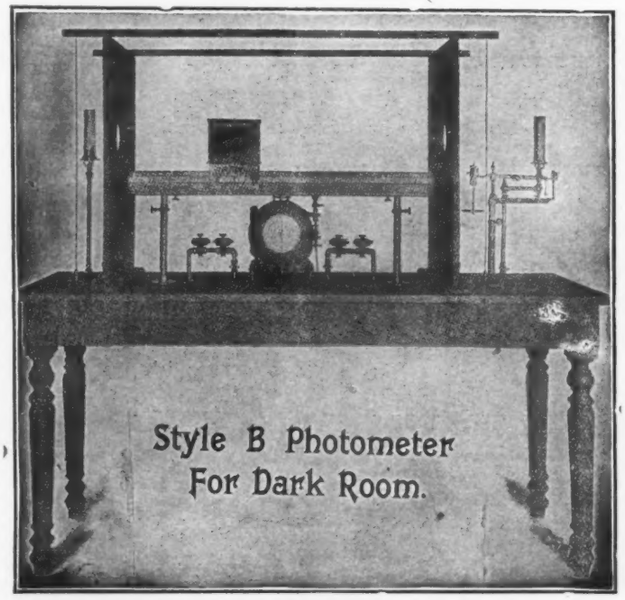
Day of Week.	Date.	Light.	Extinguish.
Fri.	1	6.20 PM	8.30 PM
Sat.	2	6.20	9.30
Sun.	3	6.30	10.40
Mon.	4	6.30	11.50
Tue.	5	6.30	12.50 AM
Wed.	6	6.30 LQ	2.00
Thu.	7	6.30	3.10
Fri.	8	6.30	4.10
Sat.	9	6.30	5.10
Sun.	10	6.30	5.20
Mon.	11	6.30	5.20
Tue.	12	6.30	5.20
Wed.	13	6.30 NM	5.20
Thu.	14	6.30	5.20
Fri.	15	6.30	5.20
Sat.	16	6.30	5.20
Sun.	17	6.40	5.10
Mon.	18	9.50	5.10
Tue.	19	10.40	5.10
Wed.	20	11.40	5.10
Thu.	21	12.30 AM FQ	5.10
Fri.	22	1.20	5.10
Sat.	23	2.10	5.10
Sun.	24	2.50	4.50
Mon.	25	3.30	4.50
Tue.	26	4.00	4.50
Wed.	27	4.30	4.50
Thu.	28	No L.	No L.
Fri	29	No L. FM	No L.
Sat.	30	No L.	No L.
Sun.	31	6.50 PM	9.40 P M

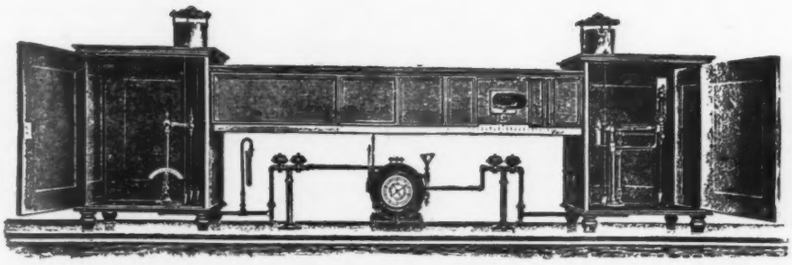
TOTAL HOURS DURING 1907.

By Table No. 1.

	Hrs.Min.
January	211.10
February	193.40
March	182.10
April	167.00
May	157.00
June	145.30
July	151.50
August	162.30
September	175.30
October	202.40
November	209.30
December	231.50
Total, yr.	2190.20







Closed Photometer For Light Room.

CIRCULARS SENT ON REQUEST.

PUBLIC LIGHTING TABLE.

MARCH, 1907.

Table No. 2.
NEW YORK CITY.
ALL NIGHT LIGHTING.

Day of Week.	Date.	Light.	Extinguish.
		P. M.	A.M.
Fri.	1	5.30	5.45
Sat.	2	5.30	5.45
Sun.	3	5.30	5.45
Mon.	4	5.30	5.45
Tue.	5	5.40	5.35
Wed.	6	5.40	5.35
Thu.	7	5.40	5.35
Fri.	8	5.40	5.35
Sat.	9	5.40	5.35
Sun.	10	5.40	5.35
Mon.	11	5.40	5.35
Tue.	12	5.50	5.20
Wed.	13	5.50	5.20
Thu.	14	5.50	5.20
Fri.	15	5.50	5.20
Sat.	16	5.50	5.20
Sun.	17	5.50	5.20
Mon.	18	5.50	5.20
Tue.	19	6.00	5.10
Wed.	20	6.00	5.10
Thu.	21	6.00	5.10
Fri.	22	6.00	5.10
Sat.	23	6.00	5.10
Sun.	24	6.00	5.10
Mon.	25	6.00	5.10
Tue.	26	6.10	4.55
Wed.	27	6.10	4.55
Thu.	28	6.10	4.55
Fri.	29	6.10	4.55
Sat.	30	6.10	4.55
Sun.	31	6.10	4.55

TOTAL HOURS DURING 1907.

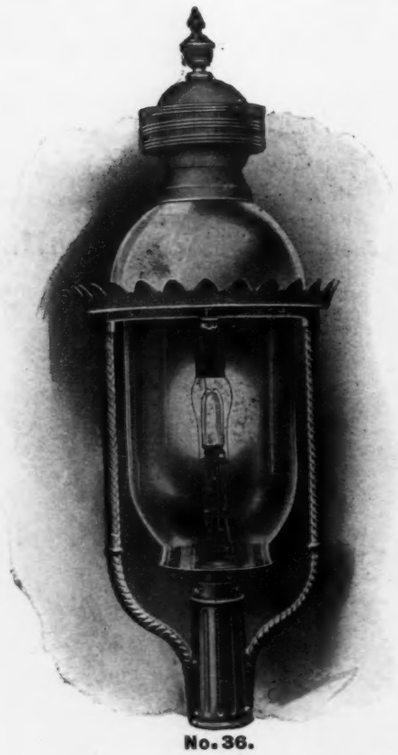
By Table No. 2.

	Hrs.Min.
January	423.20
February	355.25
March	355.35
April	298.50
May	264.50
June	234.25
July	243.45
August	280.25
September	321.15
October	374.30
November	401.40
December	433.45
Total, yr.	3987.45

NEW YORK, 318 West 42d Street. BOSTON, 820 Beacon Building. PHILADELPHIA, Broad and Arch Streets. ST. LOUIS, 712 Roe Building. CHICAGO, 218 La Salle Street. SAN FRANCISCO, 512 Oak Street.

WELSBACH STREET LIGHTING COMPANY

....OF AMERICA....



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Uniformly SUCCESSFUL in 150 Cities and Towns.

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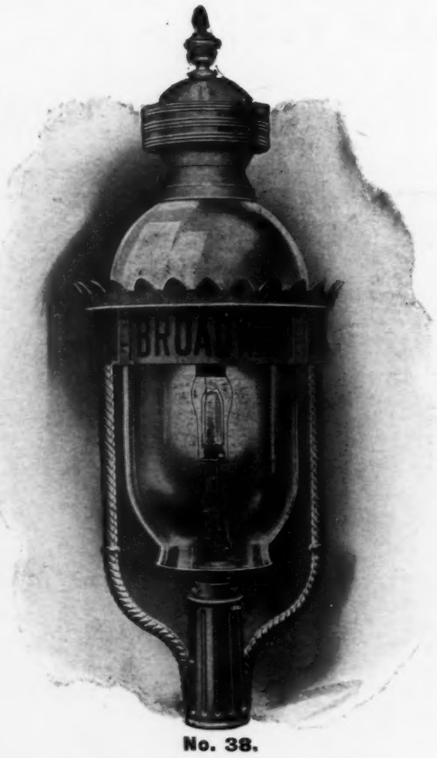

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Extra Strong and Durable.
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Rich Mellow Light.

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Allentown, Pa.
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Muskegon, Mich.
Nazareth, Pa. (2d contract).
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Greenville, Tex.
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Jefferson City, Mo.
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Milwaukee, Wis.
Syracuse, N. Y. (2d contract).
Davenport, Ia.
S. Brooklyn, N. Y. (3d contract).
Delray, Mich.
Albert Lea, Minn. (2d contract).
Leominster, Mass. (2d contract).
Clinton, Mass.

TOTAL SETS INSTALLED IN 1906, ... 41
TOTAL SETS TO DATE, ... 634
TOTAL DAILY CAPACITY, ... 502,555,000 cu. ft.

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Recording Gauges.
Straight Standpipe System for Coal Gas Retorts.
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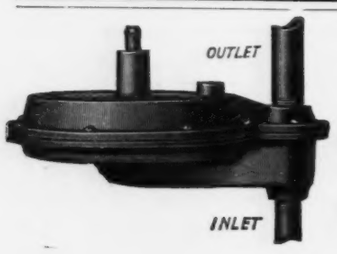

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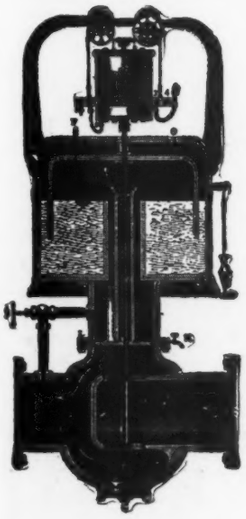

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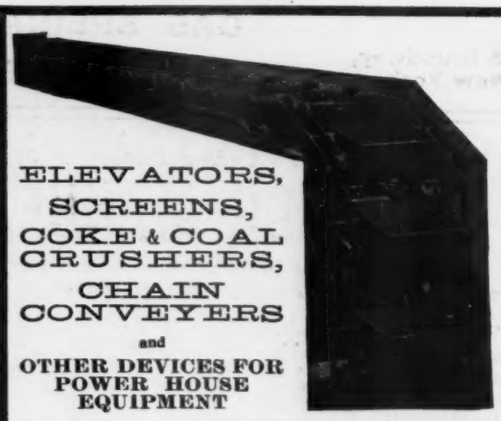

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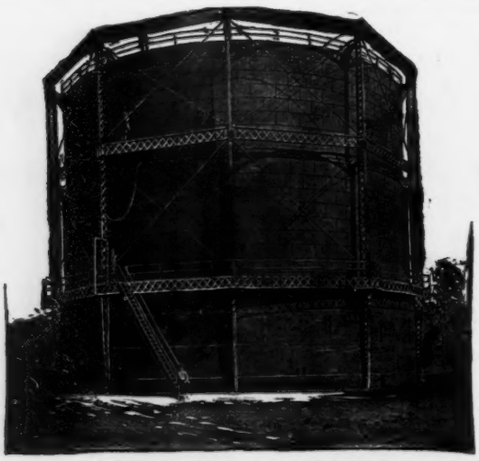

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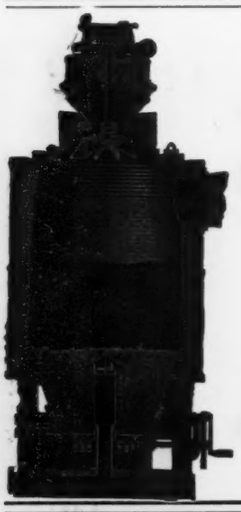

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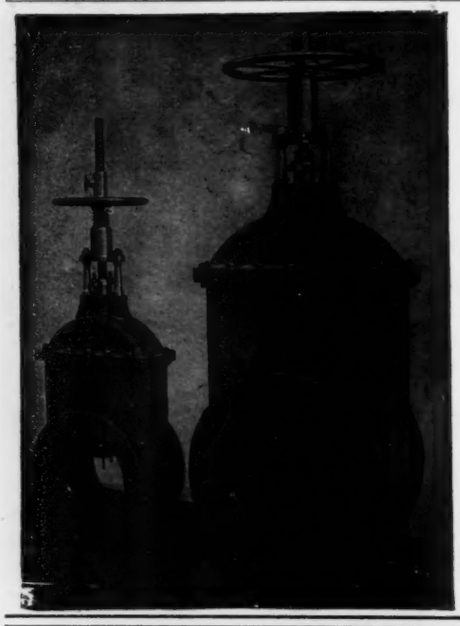

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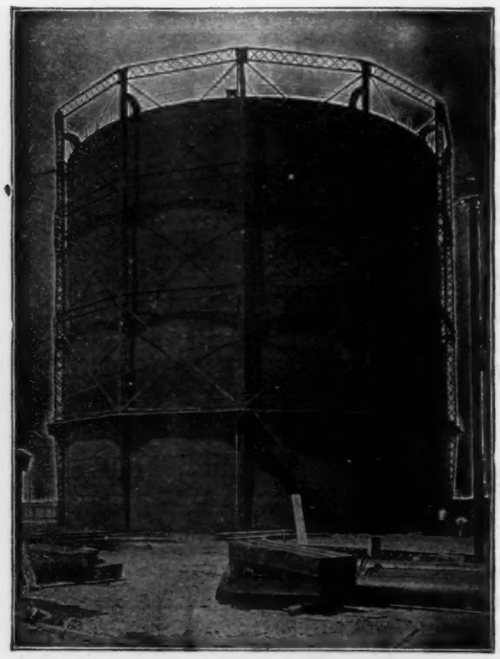

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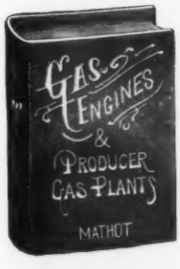

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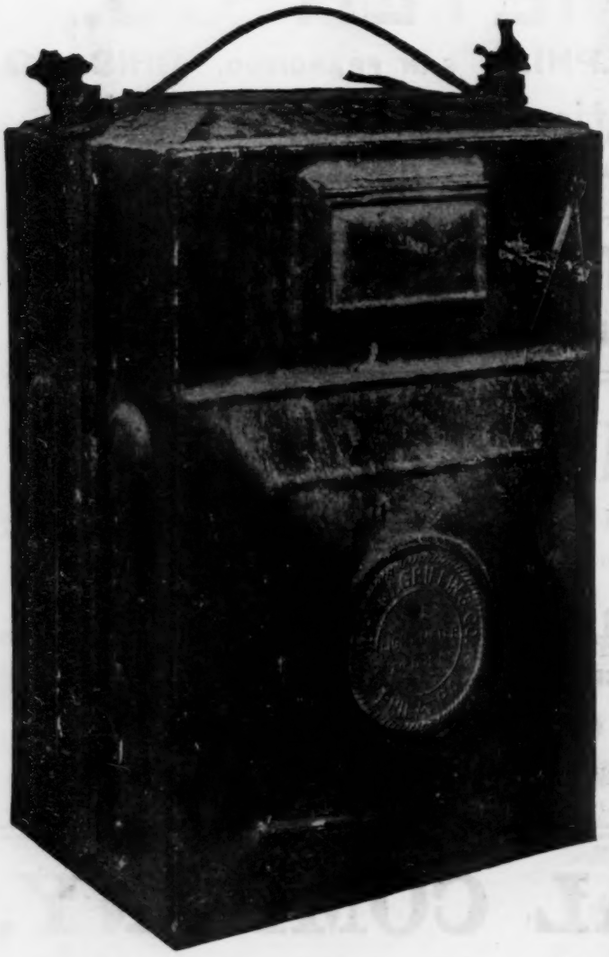

This is a photograph of a 3-light regular meter out of a lot of meters received from the Coatesville Gas Co., Coatesville, Pa., to be repaired and converted into prepayment meters.

AFTER.

This is the same meter after it has been repaired and converted into a new prepayment meter.

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